

Unit Dimension and Measurement

DPP 1.1

Basic Concepts of Units 1

Subjective Type

- Why do we have different units for the same physical quantity?
- In the following equations, the distance x is in metres, the time t in seconds and the velocity v in metres/second. What are the SI units of the constants C_1 and C_2 ?
 - $v^2 = 2C_1x$
 - $x = C_1 \cdot \cos C_2t$
 - $v = C_1e^{-C_2t}$

Single Correct Answer Type

- Which of the following is not equal to watt?
 - Joule/second
 - Ampere $\times$ volt
 - (Ampere) $^2 \times$ ohm
 - Ampere/volt
- Newton-second is the unit of
 - Velocity
 - Angular momentum
 - Momentum
 - Energy
- A suitable unit for gravitational constant is
 - $\text{kg} \cdot \text{m} \cdot \text{sec}^{-1}$
 - $\text{N} \cdot \text{m}^{-1} \cdot \text{sec}$
 - $\text{N} \cdot \text{m}^2 \cdot \text{kg}^{-2}$
 - $\text{kg} \cdot \text{m} \cdot \text{sec}^{-1}$
- The unit of angular acceleration in the SI system is
 - $\text{N} \cdot \text{kg}^{-1}$
 - $\text{m} \cdot \text{s}^{-2}$
 - $\text{rad} \cdot \text{s}^{-2}$
 - $\text{m} \cdot \text{kg}^{-1} \cdot \text{K}$
- Which of the following is not a unit of energy?
 - W-s
 - $\text{kg} \cdot \text{m}/\text{sec}$
 - N-m
 - Joule

- Temperature can be expressed as a derived quantity in terms of any of the following
 - Length and mass
 - Mass and time
 - Length, mass and time
 - None of these
- $\text{Erg} \cdot \text{m}^{-1}$ can be the unit of measure for
 - Force
 - Momentum
 - Power
 - Acceleration
- The unit of potential energy is
 - $\text{g}(\text{cm}/\text{sec}^2)$
 - $\text{g}(\text{cm}/\text{sec})^2$
 - $\text{g}(\text{cm}^2/\text{sec})$
 - $\text{g}(\text{cm}/\text{sec})$
- Which of the following represents a volt?
 - Joule/second
 - Watt/Ampere
 - Watt/Coulomb
 - Coulomb/Joule
- If the unit of length and force be increased four times, the unit of energy is
 - Increased 4 times
 - Increased 8 times
 - Increased 16 times
 - Decreased 16 times
- Ampere-hour is a unit of
 - Quantity of electricity
 - Strength of electric current
 - Power
 - Energy

Multiple Correct Answers Type

- Which of the following ratios express pressure?
 - Force/Area
 - Energy/Volume
 - Energy/Area
 - Force/Volume

Answers Key

Subjective Type

2. (a) m/s^2 , (b) m/sec , (c) m/s/sec

8. (d) 9. (a) 10. (b) 11. (b) 12. (c)
13. (a)

Single Correct Answer Type

3. (d) 4. (c) 5. (c) 6. (c) 7. (b)

Multiple Correct Answers Type

14. (a, b)

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DPP 1.2

Basic Concepts of Units 2

Subjective Type

1. Porous rock through which groundwater can move is called an aquifer. The volume V of water that, in time t , moves through a cross section of area A of the aquifer is given by $V/t = KA H/L$, where H is the vertical height of the aquifer over the horizontal distance L . This relation is called Darcy's law. The quantity K is the hydraulic conductivity of the aquifer. What are the SI units of K ?

Single Correct Answer Type

2. If u_1 and u_2 are the units selected in two systems of measurement and n_1 and n_2 their numerical values, then
 (a) $n_1 u_1 = n_2 u_2$ (b) $n_1 u_1 + n_2 u_2 = 0$
 (c) $n_1 n_2 = u_1 u_2$ (d) $(n_1 + u_1) = (n_2 + u_2)$
3. To determine the Young's modulus of a wire, the formula is $Y = \frac{F}{A} \times \frac{L}{\Delta L}$; where L = length, A = area of cross-section of the wire, ΔL = change in length of the wire when stretched with a force F . The conversion factor to change it from CGS to MKS system is
 (a) 1 (b) 10
 (c) 0.1 (d) 0.01
4. Young's modulus of a material has the same units as
 (a) Pressure (b) Strain
 (c) Compressibility (d) Force
5. Which of the following is smallest unit?
 (a) Millimetre (b) Angstrom
 (c) Fermi (d) Metre
6. Which of the following is not the unit of energy?
 (a) Calorie (b) Joule
 (c) Electron volt (d) Watt
7. In C.G.S. system the magnitude of the force is 100 dynes. In another system where the fundamental physical quantities are kilogram, metre and minute, the magnitude of the force is
 (a) 0.036 (b) 0.36
 (c) 3.6 (d) 36
8. A physical quantity is measured and its value is found to be nu where n = numerical value and u = unit. Then which of the following relations is true
 (a) $n \propto u^2$ (b) $n \propto u$
 (c) $n \propto \sqrt{u}$ (d) $n \propto \frac{1}{u}$

9. If $x = at + bt^2$, where x is the distance travelled by the body in kilometres while t is the time in seconds, then the unit of b is
 (a) km/s (b) km/s (c) km/s² (d) km/s²

10. In $S = a + bt + ct^2$, S is measured in metres and t in seconds. The unit of c is
 (a) None (b) m
 (c) ms⁻¹ (d) ms⁻²

11. The equation $\left(P + \frac{a}{V^2}\right)(V - b)$ constant. The unit of a is
 (a) Dyne $\times$ cm⁵ (b) Dyne $\times$ cm⁴
 (c) Dyne/cm³ (d) Dyne/cm²

12. A watt is:
 (a) kg m/s² (b) kg m²/s³
 (c) kg m/s (d) kg m²/s²
13. Experiment shows that two perfectly neutral parallel metal plates separated by a small distance d attract each other via a very weak force, known as the Casimir force. The force per unit area of the plates, F , depends only on the Planck constant h , on the speed of light c , and on d . Which of the following has the best chance of being correct for F ?

- (a) $F = \frac{hc}{d^2}$ (b) $F = \frac{hc}{d^4}$
 (c) $F = \frac{hd^2}{c}$ (d) $F = \frac{d^4}{hc}$

Matching Column Type

14. Suppose two students are trying to make a new measurement system so that they can use it like a code measurement system and others do not understand it. Instead of taking 1 kg, 1 m and 1 sec as basic unit they took unit of mass as a kg, the unit of length as b m and unit of time as γ second. They called power in new system as ACME then match the two columns.

Column I		Column II	
I.	1N in new system	A	$\alpha^{-1} \beta^{-2} \gamma^2$
II.	1J in new system	B	$\alpha^{-1} \beta^{-1} \gamma^2$
III.	1 Pascal (SI unit of pressure) in new system	C	$\alpha^{-1} \beta \gamma^2$
IV.	a ACME in watt	D	$\alpha^2 \beta^2 \gamma^3$

1.4 Mechanics I

Codes

- | | I | II | III | IV |
|-----|---|----|-----|----|
| (a) | B | A | C | D |
| (b) | C | B | D | A |
| (c) | A | B | D | C |
| (d) | C | D | A | B |

15. Match the column I with the column II and mark the correct option from the given codes.

Some physical quantities are given in column I and some SI units in which these quantities may be expressed are given in column II. Match the physical quantities in column I and select the code.

Column I		Column II	
I.	Gravitational field intensity $I = \frac{GM_e}{R_e^2}$; where G = gravitational constant M_e = mass of the earth R_e = radius of the earth	A	$\frac{\text{joule}}{\text{mol-kelvin}}$

II.	Electric field intensity, $E = \frac{F}{Q}$ Where F = force due to charge Q = electric charge	B	$\frac{\text{newton}}{\text{kg}}$
III.	$R = \frac{V}{I}$; where V = potential difference across a resistance I = current in the resistance	C	$\frac{\text{newton}}{\text{coulomb}}$
IV.	Universal gas constant $R = \frac{PV}{nR}$	D	$\frac{\text{volt}}{\text{ampere}}$

Codes

- | | I | II | III | IV |
|-----|---|----|-----|----|
| (a) | B | A | C | D |
| (b) | C | B | D | A |
| (c) | B | C | D | A |
| (d) | C | D | A | B |

Answers Key

Subjective Type

1. $\frac{V}{t} = \frac{KA t}{L}$; $K = \frac{V}{tA} \Rightarrow K = \frac{L^3}{tL^2} = \frac{L}{t}$; SI units = m/s

Single Correct Answer Type

2. (a) 3. (c) 4. (a) 5. (c) 6. (d)

7. (c) 8. (d) 9. (c) 10. (d) 11. (b)
12. (b) 13. (b)

Matching Column Type

14. (a) 15. (c)

DPP 1.3

Concept of Dimensional Formula 1

Subjective Type

1. Force F and density d are related as $F = \frac{\alpha}{\beta + \sqrt{d}}$, then find the dimensions of α and β .

Single Correct Answer Type

2. Select the pair whose dimensions are same
 (a) Pressure and stress (b) Stress and strain
 (c) Pressure and force (d) Power and force
3. Dimensional formula $ML^{-1}T^2$ does not represent the physical quantity
 (a) Young's modulus of elasticity
 (b) Stress
 (c) Strain
 (d) Pressure
4. Which pair has the same dimensions?
 (a) Work and power
 (b) Density and relative density
 (c) Momentum and impulse
 (d) Stress and strain
5. The dimensional formula for impulse is same as the dimensional formula for
 (a) Momentum
 (b) Force
 (c) Rate of change of momentum
 (d) Torque
6. Which of the following is dimensionally correct?
 (a) Pressure = Energy per unit area
 (b) Pressure = Energy per unit volume
 (c) Pressure = Force per unit volume
 (d) Pressure = Momentum per unit volume per unit time
7. The equation of state of some gases can be expressed as $\left(P + \frac{a}{V^2}\right)(V - b) = RT$. Here P is the pressure, V is the volume, T is the absolute temperature and a, b, R are constants. The dimensions of a are
 (a) ML^5T^{-2} (b) $ML^{-1}T^{-2}$
 (c) $M^0L^3T^0$ (d) $M^0L^6T^0$
8. The frequency of vibration f of a mass m suspended from a spring of spring constant K is given by a relation of this type $f = C m^x K^y$, where C is a dimensionless quantity. The value of x and y are
 (a) $x = \frac{1}{2}, y = \frac{1}{2}$ (b) $x = -\frac{1}{2}, y = -\frac{1}{2}$
 (c) $x = \frac{1}{2}, y = -\frac{1}{2}$ (d) $x = -\frac{1}{2}, y = \frac{1}{2}$
9. The quantities A and B are related by the relation, $m = A/B$, where m is the linear density and A is the force. The dimensions of B are of
 (a) Pressure (b) Work
 (c) Latent heat (d) None of the above
10. The velocity of a freely falling body changes as $g^p h^q$ where g is acceleration due to gravity and h is the height. The values of p and q are
 (a) $1, \frac{1}{2}$ (b) $\frac{1}{2}, \frac{1}{2}$
 (c) $\frac{1}{2}, 1$ (d) $1, 1$
11. Which one of the following does not have the same dimensions?
 (a) Work and energy
 (b) Angle and strain
 (c) Relative density and refractive index
 (d) Planck constant and energy
12. A small steel ball of radius r is allowed to fall under gravity through a column of a viscous liquid of coefficient of viscosity η . After some time the velocity of the ball attains a constant value known as terminal velocity v_T . The terminal velocity depends on (i) the mass of the ball m , (ii) η , (iii) r and (iv) acceleration due to gravity g . Which of the following relations is dimensionally correct?
 (a) $v_T \propto \frac{mg}{\eta r}$ (b) $v_T \propto \frac{\eta r}{mg}$
 (c) $v_T \propto \eta r m g$ (d) $v_T \propto \frac{m g r}{\eta}$
13. An athletic coach told his team that muscle times speed equals power. What dimensions does he view for muscle?
 (a) MLT^{-2} (b) ML^2T^{-2}
 (c) MLT^2 (d) L
14. If P represents radiation pressure, c represents speed of light and Q represents radiation energy striking a unit area per second, then non-zero integers x, y and z such that $P^x Q^y C^z$ is dimensionless are
 (a) $x = 1, y = 1, z = -1$
 (b) $x = 1, y = -1, z = 1$

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- (c) $x = -1, y = 1, z = 1$
 (d) $x = 1, y = 1, z = 1$

Fill in the Blanks Type

15. Dimensional formula for latent heat is _____
 16. The dimensions of universal gravitational constant are _____
 17. The dimensional formula of angular velocity is _____
 18. The dimensions of power are _____
 19. The dimensions of couple are _____
 20. The dimensional formula for impulse is _____
 21. The dimensional formula for Planck's constant (h) is _____
 22. The dimensions of *calorie* are _____

Answers Key

Subjective Type

1. $M^{3/2}L^{-1/2}T^{-2}, M^{1/2}L^{-3/2}$

Single Correct Answer Type

2. (a) 3. (c) 4. (c) 5. (a) 6. (b)
 7. (a) 8. (d) 9. (c) 10. (b) 11. (d)
 12. (a) 13. (a) 14. (b)

Fill in the Blanks Type

15. $M^0L^2T^{-2}$ 16. $M^{-1}L^3T^{-2}$ 17. $M^0L^0T^{-1}$
 18. $M^1L^2T^{-3}$ 19. ML^2T^{-2} 20. MLT^{-1}
 21. ML^2T^{-1} 22. ML^2T^{-2}

Concept of Dimensional Formula 2

Subjective Type

1. A particle of mass m is located in a region where its potential energy $[U(x)]$ depends on the position x as

Potential Energy $[U(x)] = \frac{1}{x^2} - \frac{b}{x}$ here a and b are positive constants ...

- (i) Write dimensional formula of a and b
 (ii) If the time period of oscillation which is calculated from above formula is stated by a student as $T = 4\pi a \sqrt{\frac{ma}{b^2}}$, check whether his answer is dimensionally correct.

Single Correct Answer Type

2. If velocity v , acceleration A and force F are chosen as fundamental quantities, then the dimensional formula of angular momentum in terms of v , A and F would be
 (a) $FA^{-1}v$ (b) Fv^3A^{-2} (c) Fv^2A^{-1} (d) $F^2v^2A^{-1}$
3. Two quantities A and B have different dimensions. Which mathematical operation given below is physically meaningful?
 (a) A/B (b) $A+B$ (c) $A-B$ (d) None
4. A force F is given by $F = at + bt^2$, where t is time. What are the dimensions of a and b ?
 (a) MLT^{-3} and ML^2T^{-4} (b) MLT^{-3} and MLT^{-4}
 (c) MLT^{-1} and MLT^0 (d) MLT^{-4} and MLT^{-1}
5. If the speed of light (c), acceleration due to gravity (g) and pressure (p) are taken as the fundamental quantities, then the dimension of gravitational constant is
 (a) $c^2g^0p^{-2}$ (b) $c^0g^2p^{-1}$ (c) cg^3p^{-2} (d) $c^{-1}g^0p^{-1}$
6. If the time period (T) of vibration of a liquid drop depends on surface tension (S), radius (r) of the drop and density (ρ) of the liquid, then the expression of T is
 (a) $T = k\sqrt{\rho r^3/S}$ (b) $T = k\sqrt{\rho^{1/2}r^3/S}$
 (c) $T = k\sqrt{\rho r^3/S^{1/2}}$ (d) None of these
7. If pressure P , velocity V and time T are taken as fundamental physical quantities, the dimensional formula of force is
 (a) PV^2T^2 (b) $P^{-1}V^2T^{-2}$ (c) PVT^2 (d) $P^{-1}VT^2$
8. If energy (E), velocity (v) and force (F) be taken as fundamental quantity, then what are the dimensions of mass
 (a) Ev^2 (b) Ev^{-2} (c) Fv^{-1} (d) Fv^{-2}
9. A physical quantity x depends on quantities y and z as follows: $x = Ay + B \tan Cz$, where A , B and C are constants. Which of the following do not have the same dimensions?
 (a) x and B (b) C and z^{-1}
 (c) y and B/A (d) x and A
10. If the velocity of light (c), gravitational constant (G) and Planck's constant (h) are chosen as fundamental units, then the dimensions of mass in new system is
 (a) $c^{1/2}G^{1/2}h^{1/2}$ (b) $c^{1/2}G^{1/2}h^{-1/2}$
 (c) $c^{1/2}G^{-1/2}h^{1/2}$ (d) $c^{-1/2}G^{1/2}h^{1/2}$
11. If force (F), length (L) and time (T) are assumed to be fundamental units, then the dimensional formula of the mass will be
 (a) $FL^{-1}T^2$ (b) $FL^{-1}T^{-2}$ (c) $FL^{-1}T^{-1}$ (d) FL^2T^2
12. Position of a body with acceleration ' a ' is given by $x = Ka^m t^n$, here t is time. Find dimension of m and n .
 (a) $m = 1, n = 1$ (b) $m = 1, n = 2$
 (c) $m = 2, n = 1$ (d) $m = 2, n = 2$
13. In a system of units if force (F), acceleration (A) and time (T) are taken as fundamental units, then the dimensional formula of energy is
 (a) FA^2T (b) FAT^2 (c) F^2AT (d) FAT
14. Density of a liquid in CGS system is 0.625 g/cm^3 . What is its magnitude in SI system?
 (a) 0.625 (b) 0.0625
 (c) 0.00625 (d) 625
15. If the speed v of a particle of mass m as function of time t is given by $v = \omega A \sin \left[\left[\sqrt{\frac{k}{m}} t \right] \right]$, where A has dimension of length.
 (a) the argument of trigonometric function must be a dimensionless quantity
 (b) Dimensional formula of ω is LT^{-1}
 (c) Dimensional formula of k is MLT^{-2}
 (d) Dimensional formula of $\sqrt{\frac{k}{m}}$ is T

Answers Key

Single Correct Answer Type

- | | | | | | | | | | |
|--------|--------|--------|--------|--------|---------|---------|---------|---------|---------|
| 2. (b) | 3. (a) | 4. (b) | 5. (b) | 6. (a) | 7. (a) | 8. (b) | 9. (d) | 10. (c) | 11. (a) |
| | | | | | 12. (b) | 13. (b) | 14. (d) | 15. (a) | |

DPP 1.5

Errors of Measurement 1

Subjective Type

- Time for 20 oscillations of a pendulum is measured as $t_1 = 39.6$ s; $t_2 = 39.9$ s and $t_3 = 39.5$ s. What is the precision in the measurements? What is the accuracy of the measurement?
- A physical quantity X is related to four measurable quantities a , b , c and d as follows $X = a^2 b^3 c^{5/2} d^{-2}$. The percentage error in the measurement of a , b , c and d are 1%, 2%, 3% and 4%, respectively. What is the percentage error in quantity X ? If the value of X calculated on the basis of the above relation is 2.763, to what value should you round off the result.

Single Correct Answer Type

- What is the number of significant figures in 0.310×10^3 ?
(a) 2 (b) 3 (c) 4 (d) 6
- The number of significant figures in 0.06900 is
(a) 5 (b) 4 (c) 2 (d) 3
- The sum of the numbers 436.32, 227.2 and 0.301 in appropriate significant figures is
(a) 663.821 (b) 664
(c) 663.8 (d) 663.82
- The mass and volume of a body are 4.237 g and 2.5 cm^3 , respectively. The density of the material of the body in correct significant figures is
(a) 1.6048 g cm^{-3} (b) 1.69 g cm^{-3}
(c) 1.7 g cm^{-3} (d) 1.695 g cm^{-3}
- The numbers 2.745 and 2.735 on rounding off to 3 significant figures will give
(a) 2.75 and 2.74 (b) 2.74 and 2.73
(c) 2.75 and 2.73 (d) 2.74 and 2.74
- The length and breadth of a rectangular sheet are 16.2 cm and 10.1 cm, respectively. The area of the sheet in appropriate significant figures and error is
(a) $164 \pm 3 \text{ cm}^2$ (b) $163.62 \pm 2.6 \text{ cm}^2$
(c) $163.6 \pm 2.6 \text{ cm}^2$ (d) $163.62 \pm 3 \text{ cm}^2$
- The decimal equivalent of $1/20$ up to three significant figures is
(a) 0.0500 (b) 0.05000
(c) 0.0050 (d) 5.0×10^{-2}
- In the context of accuracy of measurement and significant figures in expressing results of experiment, which of the following is/are correct
(1) Out of the two measurements 50.14 cm and 0.00025 ampere, the first one has greater accuracy
(2) If one travels 478 km by rail and 397 m by road, the total distance travelled is 478 km.
(a) Only (1) is correct (b) Only (2) is correct
(c) Both are correct (d) None of them is correct
- If $L = 2.331$ cm, $B = 2.1$ cm, then $L + B =$
(a) 4.431 cm (b) 4.43 cm
(c) 4.4 cm (d) 4 cm
- Measure of two quantities along with the precision of respective measuring instrument is
 $A = 2.5 \text{ ms}^{-1} \pm 0.5 \text{ ms}^{-1}$, $B = 0.10 \text{ s} \pm 0.01 \text{ s}$. The value of AB will be
(a) $(0.25 \pm 0.08) \text{ m}$ (b) $(0.25 \pm 0.5) \text{ m}$
(c) $(0.25 \pm 0.05) \text{ m}$ (d) $(0.25 \pm 0.135) \text{ m}$
- You measure two quantities as $A = 1.0 \text{ m} \pm 0.2 \text{ m}$, $B = 2.0 \text{ m} \pm 0.2 \text{ m}$. We should report correct value for $\sqrt{AB}$ as
(a) $1.4 \text{ m} \pm 0.4 \text{ m}$ (b) $1.41 \text{ m} \pm 0.15 \text{ m}$
(c) $1.4 \text{ m} \pm 0.3 \text{ m}$ (d) $1.4 \text{ m} \pm 0.2 \text{ m}$
- Which of the following measurement is most precise?
(a) 5.00 mm (b) 5.00 cm
(c) 5.00 m (d) 5.00 km
- The mean length of an object is 5 cm. Which of the following measurements is most accurate?
(a) 4.9 cm (b) 4.805 cm
(c) 5.25 cm (d) 5.4 cm

Answers Key

Subjective Type

- Accuracy of measurement = ± 0.2 s
- $\pm 23.5\%$, 2.8

Single Correct Answer Type

- | | | | | |
|---------|---------|---------|---------|---------|
| 3. (b) | 4. (b) | 5. (b) | 6. (c) | 7. (d) |
| 8. (a) | 9. (a) | 10. (c) | 11. (c) | 12. (a) |
| 13. (d) | 14. (a) | 15. (a) | | |

Errors of Measurement 2

Single Correct Answer Type

1. The period of oscillation of a simple pendulum is given by $T = 2\pi\sqrt{\frac{l}{g}}$ where l is about 100 cm and is known to have 1 mm accuracy. The period is about 2 s. The time of 100 oscillations is measured by a stop watch of least count 0.1 s. The percentage error in g is
(a) 0.1% (b) 1% (c) 0.2% (d) 0.8%
2. The percentage errors in the measurement of mass and speed are 2% and 3% respectively. How much will be the maximum error in the estimation of the kinetic energy obtained by measuring mass and speed
(a) 11% (b) 8% (c) 5% (d) 1%
3. Error in the measurement of radius of a sphere is 1%. The error in the calculated value of its volume is
(a) 1% (b) 3% (c) 5% (d) 7%
4. The mean time period of second's pendulum is 2.00 s and mean absolute error in the time period is 0.05 s. To express maximum estimate of error, the time period should be written as
(a) (2.00 ± 0.01) s (b) $(2.00 + 0.025)$ s
(c) (2.00 ± 0.05) s (d) (2.00 ± 0.10) s
5. A body travels uniformly a distance of (13.8 ± 0.2) m in a time (4.0 ± 0.3) s. The velocity of the body within error limits is
(a) $(3.45 \pm 0.2) \text{ ms}^{-1}$ (b) $(3.45 \pm 0.3) \text{ ms}^{-1}$
(c) $(3.45 \pm 0.4) \text{ ms}^{-1}$ (d) $(3.45 \pm 0.5) \text{ ms}^{-1}$
6. The percentage error in the above problem is
(a) 7% (b) 5.95%
(c) 8.95% (d) 9.85%
7. A physical parameter a can be determined by measuring the parameters b, c, d and e using the relation $a = \frac{b^\alpha c^\beta}{d^\gamma e^\delta}$.
If the maximum errors in the measurement of b, c, d and e are $b_1\%$, $c_1\%$, $d_1\%$ and $e_1\%$, then the maximum error in the value of a determined by the experiment is
(a) $(b_1 + c_1 + d_1 + e_1)\%$
(b) $(b_1 + c_1 - d_1 - e_1)\%$
(c) $(\alpha b_1 + \beta c_1 - \gamma d_1 - \delta e_1)\%$
(d) $(\alpha b_1 + \beta c_1 + \gamma d_1 + \delta e_1)\%$
8. The relative density of material of a body is found by weighing it first in air and then in water. If the weight in air is (5.00 ± 0.05) Newton and weight in water is (4.00 ± 0.05) Newton. Then the relative density along with the maximum permissible percentage error is
(a) $5.0 \pm 11\%$ (b) $5.0 \pm 1\%$
(c) $5.0 \pm 6\%$ (d) $1.25 \pm 5\%$
9. The period of oscillation of a simple pendulum in the experiment is recorded as 2.63 s, 2.56 s, 2.42 s, 2.71 s and 2.80 s respectively. The average absolute error is
(a) 0.1 s (b) 0.11 s
(c) 0.01 s (d) 1.0 s
10. The length of a cylinder is measured with a meter rod having least count 0.1 cm. Its diameter is measured with vernier calipers having least count 0.01 cm. Given that length is 5.0 cm and radius is 2.0 cm. The percentage error in the calculated value of the volume will be
(a) 1% (b) 2% (c) 3% (d) 4%
11. In an experiment, the following observation's were recorded : $L = 2.820$ m, $M = 3.00$ kg, $l = 0.087$ cm, Diameter $D = 0.041$ cm Taking $g = 9.81 \text{ m/s}^2$ using the formula, $Y = \frac{4MgL}{\pi D^2 l}$, the maximum permissible error in Y is
(a) 7.96% (b) 4.56%
(c) 6.50% (d) 8.42%
12. If there is a positive error of 50% in the measurement of velocity of a body, then the error in the measurement of kinetic energy is
(a) 25% (b) 50%
(c) 100% (d) 125%
13. A physical quantity A is related to four observable a, b, c and d as follows, $A = \frac{a^2 b^3}{c \sqrt{d}}$, the percentage errors of measurement in a, b, c and d are 1%, 3%, 2% and 2% respectively. What is the percentage error in the quantity A ?
(a) 12% (b) 7% (c) 5% (d) 14%
14. A wire has a mass 0.3 ± 0.003 g, radius 0.5 ± 0.005 mm and length 6 ± 0.06 cm. The maximum percentage error in the measurement of its density is
(a) 1 (b) 2 (c) 3 (d) 4

Answers Key

Single Correct Answer Type

- | | | | |
|---------|---------|---------|---------|
| 1. (c) | 2. (b) | 3. (b) | 4. (c) |
| 5. (b) | 6. (c) | 7. (d) | 8. (a) |
| 9. (b) | 10. (c) | 11. (c) | 12. (d) |
| 13. (d) | 14. (d) | | |

DPP 2.1

Trigonometry and Algebra

Subjective Type

- Find the value of $\sin (105^\circ)$.
- Compute $\tan 22\frac{1^\circ}{2}$.
- Solve the equation $\sin^2 x - \cos^2 x = \frac{1}{2}$
- Calculate $\sqrt{26}$ correct to two places of decimal.
- Given that acceleration due to gravity varies inversely as the square of the distance from the center of earth, find its value at a height of 64 km from the earth's surface, if the value at the surface be 9.81 ms^{-2} . Radius of earth = 6400 km.

Single Correct Answer Type

- Convert 18 degree into radians.

- | | |
|----------------------------------|-----------------------------------|
| (a) $\frac{\pi}{10} \text{ rad}$ | (b) $\frac{\pi}{180} \text{ rad}$ |
| (c) $\frac{\pi}{18} \text{ rad}$ | (d) $\frac{18}{\pi}$ |

- Value of $\sin (37^\circ) \cos (53^\circ)$ is

- | | |
|---------------------|---------------------|
| (a) $\frac{9}{25}$ | (b) $\frac{12}{25}$ |
| (c) $\frac{16}{25}$ | (d) $\frac{3}{5}$ |

- If $\sin \theta = \frac{1}{3}$, then $\cos \theta$ will be

- | | |
|---------------------------|-------------------|
| (a) $\frac{8}{9}$ | (b) $\frac{4}{3}$ |
| (c) $\frac{2\sqrt{2}}{3}$ | (d) $\frac{3}{4}$ |

- $\sin (90^\circ + \theta)$ is

- | | |
|--------------------|--------------------|
| (a) $\sin \theta$ | (b) $\cos \theta$ |
| (c) $-\cos \theta$ | (d) $-\sin \theta$ |

- $\cos (30^\circ)$ is equal to

- | | |
|--------------------------|-------------------|
| (a) $\frac{\sqrt{3}}{2}$ | (b) $\frac{1}{2}$ |
| (c) $\frac{1}{\sqrt{2}}$ | (d) None |

- If $\sin \theta = \frac{1}{3}$, then $\cos \theta$ will be

- | | |
|---------------------------|-------------------|
| (a) $\frac{8}{9}$ | (b) $\frac{4}{3}$ |
| (c) $\frac{2\sqrt{2}}{3}$ | (d) $\frac{3}{4}$ |

Multiple Correct Answers Type

12. Which of the following has value 1:
 (a) $\tan 45^\circ$ (b) $\sin 90^\circ$
 (c) $\cos 90^\circ$ (d) $\cos 0^\circ$
13. Which of the following has value zero?
 (a) $\sin 0^\circ$ (b) $\tan 0^\circ$
 (c) $\cos 0^\circ$ (d) $\cot 0^\circ$

Matching Column Type

14. Match the following columns:

Column I	Column II
(a) $\sin 37^\circ$	(P) $-\frac{3}{5}$
(b) $\cos 127^\circ$	(Q) $\frac{3}{5}$
(c) $\tan 307^\circ$	(R) $-\frac{4}{3}$
(d) $\cos 307^\circ$	(S) $\frac{4}{3}$
(e) $\cos (53^\circ)$	(T) $\frac{3}{4}$

Answers Key**Subjective Type**

1. $\frac{1}{4}(\sqrt{6} + \sqrt{2})$ 2. $(\sqrt{2} - 1)$
 3. $x = 60^\circ, 120^\circ, 240^\circ, 300^\circ$, etc. 4. 5.10
 5. 9.61

Multiple Correct Answers Type

12. (a,b,d) 13. (a, b)

Matching Column Type

14. $(a \rightarrow Q), (b \rightarrow P), (c \rightarrow R), (d \rightarrow Q), (e \rightarrow Q)$

Single Correct Answer Type

6. (a) 7. (a) 8. (c) 9. (b) 10. (a)
 11. (c)

DPP 2.2

Curve Plotting

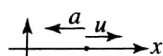
Subjective Type

1. For a particle moving along straight line with constant acceleration (a), we define velocity of the particle with time as

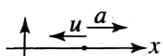
$$v = u + at, \text{ (} u = \text{initial velocity)}$$

Draw the velocity-time graph of the particle in following situations.

- (i) Velocity is decreasing with time (i.e. acceleration is negative)



- (ii) Initial velocity is negative but acceleration is positive



2. A particle is moving along x -direction with a constant acceleration a . The particle starts from $x = x_0$ position with initial velocity u . We can define the position of the particle with time by the relation

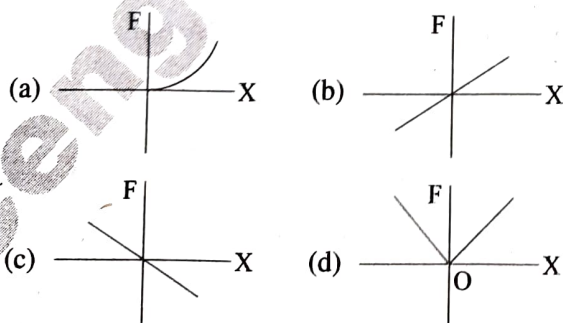
$$x = x_0 + ut + \frac{1}{2}at^2$$

plot the position of the particle in relation with time in following situations

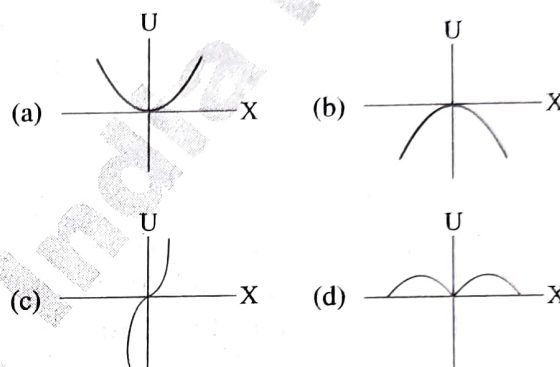
- (i) If initial position of the particle is on negative x -axis, initial velocity is positive and acceleration is negative.
 (ii) If initial position is positive, initial velocity is negative and acceleration is positive.

Single Correct Answer Type

3. The spring force is given by $F = -kx$, here k is a constant and x is the deformation of spring. The F - x graph is

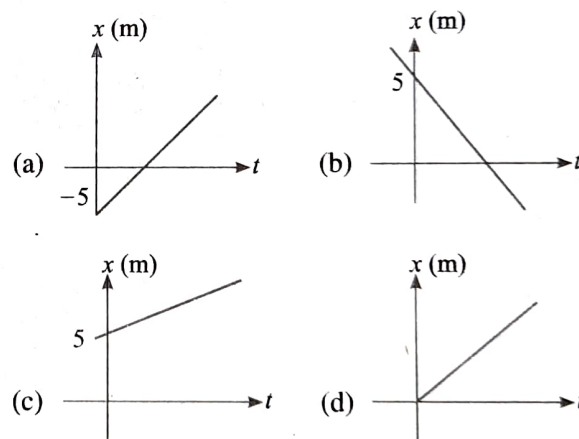


4. A body is attached to a spring whose other end is fixed. If the spring is elongated by x , its potential energy is $U = 5x^2$, where x is in metre and U is in joule. U - x graph is

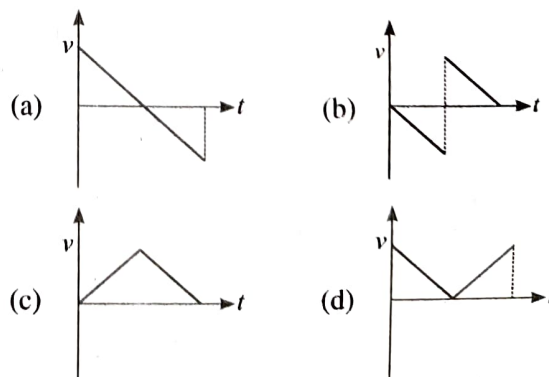


5. A particle starts moving with constant velocity $v = 2$ m/s, from position $x = 5$ m.

The position time graph will be

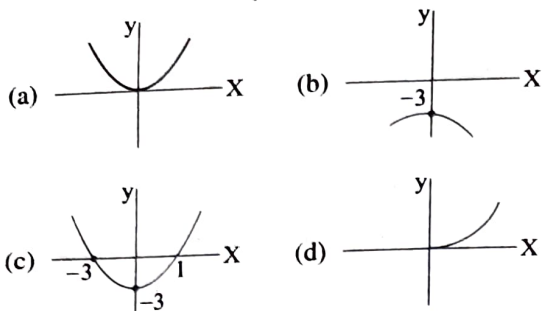


6. A stone is allowed to fall freely from a certain height. Neglecting air resistance, which graph represents the variation of velocity ' v ' with time ' t '?

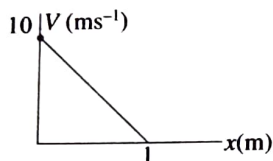


2.4 Mechanics I

7. If $y = x^2 + 2x - 3$, $y-x$ graph is



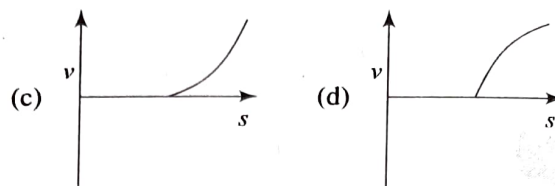
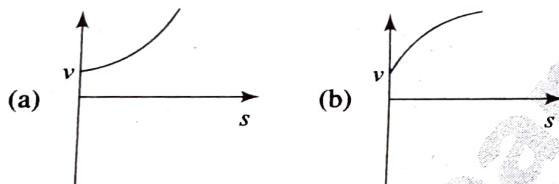
8. The velocity displacement graph of a particle moving along a straight line is shown in figure.



The velocity as function of $x(0 \leq x \leq 1)$ is

- (a) $-10x$ (b) $-10x + 10$
(c) $10x - 10$ (d) $-10x^2 + 10x + 10$

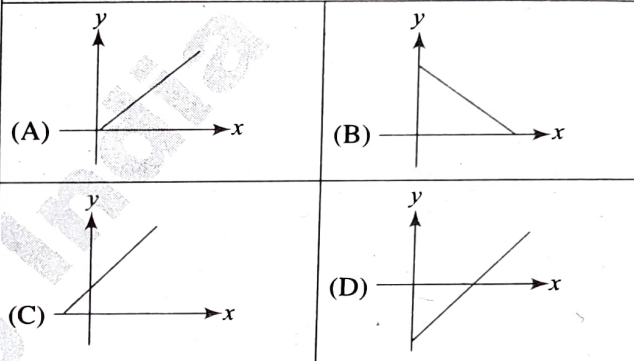
9. Which of the following best represents the graph of velocity (v) versus displacement (s) for a particle travelling with an acceleration (uniform) and some non zero initial velocity?



Matching Column Type

10. In list I some straight lines graphs are given and in list II corresponding signs of slopes and intercepts are given. Match the type of graphs of list I corresponding to signs of slopes and intercepts in list II

List I

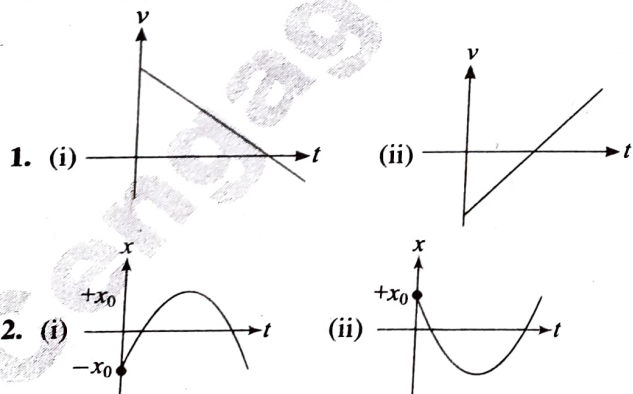


List II

(i) Positive slope	(ii) Negative slope
(iii) Positive intercept	(iv) Negative intercept
(v) Zero intercept	(vi) Zero slope

Answers Key

Subjective Type



Single Correct Answer Type

3. (c) 4. (a) 5. (c) 6. (c) 7. (c)
8. (b) 9. (d)

Matching Column Type

10. A (i), (v) B (ii), (iii) C (i), (iii) D (i), (iv)

DPP 2.3

Basic Differentiation 1

Single Correct Answer Type

- Differentiation of $\sin(x^2)$ w.r.t. x is
 - $\cos(x^2)$
 - $2x \cos(x^2)$
 - $x^2 \cos(x^2)$
 - $-\cos(2x)$
- If $y = 2 \sin^2 \theta + \tan \theta$ then $\frac{dy}{d\theta}$ will be
 - $4 \sin \theta \cos \theta + \sec \theta \tan \theta$
 - $2 \sin 2\theta + \sec^2 \theta$
 - $4 \sin \theta + \sec^2 \theta$
 - $2 \cos^2 \theta + \sec^2 \theta$
- If $y = \sin x$ & $x = 3t$ then $\frac{dy}{dt}$ will be
 - $3 \cos(x)$
 - $\cos x$
 - $-3 \cos(x)$
 - $-\cos x$
- If $y = \sin(t^2)$, then $\frac{d^2y}{dt^2}$ will be
 - $2t \cos(t^2)$
 - $2 \cos(t^2) - 4t^2 \sin(t^2)$
 - $4t^2 \sin(t^2)$
 - $2 \cos(t^2)$
- The displacement of a body at any time t after starting is given by $s = 10t - \frac{1}{2}(0.2)t^2$. The velocity of the body is zero after:
 - 50 s
 - 100 s
 - 80 s
 - 40 s
- If $y = x^2 \sin x + \frac{3x}{\tan x}$, then $\frac{dy}{dx}$ will be
 - $2x \sin x + x^2 \cos x + \frac{3 \tan x - 3x \sec^2 x}{\tan^2 x}$
 - $2x \sin x + \frac{3x \sec^2 x - 3 \tan x}{\tan^2 x}$
 - $\frac{x^2 \cos x + (3 \tan x - 3x \sec^2 x)}{\tan^2 x}$
 - $\frac{x^2 \cos x - 2x \sin x - (3 \tan x - 3x \sec^2 x)}{\tan^2 x}$

Comprehension Type

For Problems 7 and 8

If a particle starts moving along a straight line with initial velocity u under constant acceleration a , its displacement with time is given by the relation

$$x = ut + \frac{1}{2}at^2$$

7. Differentiation of ' x ' w.r.t. ' t ' will be

- $y = \frac{at}{2}$
- $u + at$
- $u + 2at$
- $\frac{ut^2}{2} + \frac{at^3}{6}$

8. The concerned deviation of position time relation w.r.t will be. Differentiation of above result w.r.t. ' t ' will be

- a
- $u + a$
- u
- none

For Problems 9 and 10

If charge flown through a wire is given by $q = 3 \sin(3t)$, then

9. Find out the amount of charge flown through the wire at

$$t = \left(\frac{\pi}{6}\right) \text{ seconds.}$$

- 3 coulombs
- 6 coulombs
- 1 coulomb
- Zero coulomb

10. Find out the current flown through the wire at $t = \frac{\pi}{9}$ second.

- 4.5 Amp
- $4.5\sqrt{3}$ Amp
- $\frac{\sqrt{3}}{2}$ Amp
- 9 Amp

For Problems 11-14

Velocity of a particle varies as

$$v = 2t^3 - 3t^2 \text{ in km/hr}$$

If $t = 0$ is taken at 12:00 noon

11. Find the expression for the acceleration of the particle.

- $3t^2 + 3t$
- $6t(t - 1)$
- $6t^2 + 3t$
- none

12. Find the time between 12:00 noon and 1:00 pm at which speed is maximum.

- 12:00 noon
- 1:00 pm
- 11:00 am
- 2:00 pm

2.6 Mechanics I

13. The time at which speed of the particle is minimum.
 (a) 12:00 noon (b) 1:00 pm
 (c) 11:00 am (d) 2:00 pm
14. What is the velocity of the particle at 12:00 noon?
 (a) 0.5 km/hr (b) zero
 (c) 1 km/hr (d) 2 km/hr

Fill In The Blanks

15. If $y = f(x) = 3x^2 + 2x + 4$, then value of y at $x = f(2)$ will be...
16. Differentiation of x^2 w.r.t. x is...
17. If $y = \frac{1}{x^4}$, then $\frac{dy}{dx}$ will be...
18. Differentiation of $2x^2 + 3x$ w.r.t. x is...
19. If square of x varies as cube of y and $x = 3$ when $y = 4$, the value of y at $\frac{1}{\sqrt{3}}$ will be...

20. If $y = 2 \sin x$, then dy/dx will be...
21. If $y = \sin x$, then $\frac{d^2y}{dx^2}$ will be ...
22. Double differentiation of displacement w.r.t. time is...
23. If $y = x^3$ then $\frac{d^2y}{dx^2}$ is...
24. If velocity of particle is given by $v = 2t^4$, then its acceleration (dv/dt) at any time t will be given by...
25. If $y = 2 \sin (\omega t + \phi)$ where ω and ϕ constants then dy/dt will be ...
26. If $y = x^2 \sin x$, then $\frac{dy}{dx}$ will be ...
27. If $y = \tan x \cdot \cos^2 x$ then $\frac{dy}{dx}$ will be ...

Answers Key

Single Correct Answer Type

1. (b) 2. (b) 3. (a) 4. (b) 5. (a)
 6. (a)

Comprehension Type

7. (b) 8. (a) 9. (a) 10. (a) 11. (b)
 12. (a) 13. (a) 14. (b)

Fill In The Blanks

15. 1244 16. $2x$ 17. $-\frac{4}{x^5}$ 18. $4x+3$

19. $\frac{4}{3}$
 20. $2 \cos x$ 21. $-\sin x$
 22. acceleration 23. $6x$
 24. $8t^3$ 25. $2\omega \cos (\omega t + \phi)$
 26. $x^2 \cos x + 2x \sin x$ 27. $1 - 2 \sin^2 x$

DPP 2.4

Basic Differentiation 2

Single Correct Answer Type

1. $\frac{d}{dx} \left(\sqrt{x} + \frac{1}{\sqrt{x}} \right)^2 =$

- (a) $1 - \frac{1}{x^2}$ (b) $1 + \frac{1}{x^2}$
(c) $1 - \frac{1}{2x}$ (d) None of these

2. If $y = \frac{1}{a-z}$, then $\frac{dz}{dy} =$

- (a) $(z-a)^2$ (b) $-(z-a)^2$
(c) $(z+a)^2$ (d) $-(z+a)^2$

3. If $y = x \sin x$, then

- (a) $\frac{1}{y} \frac{dy}{dx} = \frac{1}{x} + \cot x$ (b) $\frac{dy}{dx} = \frac{1}{x} + \cot x$
(c) $\frac{1}{y} \frac{dy}{dx} = \frac{1}{x} - \cot x$ (d) None of these

4. If $y = \cos(\sin x^2)$, then at $x = \sqrt{\frac{\pi}{2}}$, $\frac{dy}{dx} =$

- (a) -2 (b) 2
(c) $-2\sqrt{\frac{\pi}{2}}$ (d) 0

5. $f(x) = x^2 - 3x$, then the points at which $f(x) = f'(x)$ are

- (a) 1, 3 (b) 1, -3
(c) -1, 3 (d) None of these

6. If $f(x) = mx + c$, $f(0) = f'(0) = 1$ then $f(2) =$

- (a) 1 (b) 2 (c) 3 (d) -3

7. If $x = \sqrt{1-y^2}$, then $\frac{dy}{dx} =$

- (a) 0 (b) x

(c) $\frac{\sqrt{1-y^2}}{1-2y^2}$

(d) $\frac{\sqrt{1-y^2}}{1+2y^2}$

8. If $f(x) = \sqrt{ax} + \frac{a^2}{\sqrt{ax}}$, then $f'(a) =$

- (a) -1 (b) 1 (c) 0 (d) a

9. If $x = \frac{1-t^2}{1+t^2}$ and $y = \frac{2at}{1+t^2}$, then $\frac{dy}{dx} =$

- (a) $\frac{a(1-t^2)}{2t}$ (b) $\frac{a(t^2-1)}{2t}$
(c) $\frac{a(t^2+1)}{2t}$ (d) $\frac{a(t^2-1)}{t}$

10. If $x = \frac{1-t^2}{1+t^2}$ and $y = \frac{2t}{1+t^2}$, then $\frac{dy}{dx} =$

- (a) $\frac{-y}{x}$ (b) $\frac{y}{x}$ (c) $\frac{-x}{y}$ (d) $\frac{x}{y}$

11. If $x = at^2$, $y = 2at$, then $\frac{d^2y}{dx^2} =$

- (a) $-\frac{1}{t^2}$ (b) $\frac{1}{2at^3}$ (c) $-\frac{1}{t^3}$ (d) $-\frac{1}{2at^3}$

12. $x\sqrt{1+y} + y\sqrt{1+x} = 0$, then $\frac{dy}{dx} =$

- (a) $1+x$ (b) $(1+x)^{-2}$
(c) $-(1+x)^{-1}$ (d) $-(1+x)^{-2}$

13. If $x = 2 \cos t - \cos 2t$, $y = 2 \sin t - \sin 2t$, then at $t = \frac{\pi}{4}$, $\frac{dy}{dx} =$

- (a) $\sqrt{2}+1$ (b) $\sqrt{2}-1$

- (c) $\frac{\sqrt{2}+1}{2}$ (d) None of these

14. If $y = a \sin x + b \cos x$, then $y^2 + \left(\frac{dy}{dx} \right)^2$ is a

- (a) Function of x (b) Function of y
(c) Function of x and y (d) Constant

Answers Key

Single Correct Answer Type

1. (a) 2. (a) 3. (a) 4. (d) 5. (d) 6. (c) 7. (c) 8. (c) 9. (b) 10. (c)
11. (d) 12. (d) 13. (a) 14. (d)

DPP 2.5

Maxima and Minima

Single Correct Answer Type

- The value of the function $(x-1)(x-2)^2$ at its maxima is
(a) 1 (b) 2 (c) 0 (d) $\frac{4}{27}$
- The adjacent sides of a rectangle with given perimeter as 100 cm and enclosing maximum area are
(a) 10 cm and 40 cm (b) 20 cm and 30 cm
(c) 25 cm and 25 cm (d) 15 cm and 35 cm
- The area of a rectangle will be maximum for the given perimeter, when rectangle is a
(a) Parallelogram (b) Trapezium
(c) Square (d) None of these
- If $x + y = 10$, then the maximum value of xy is
(a) 5 (b) 20
(c) 25 (d) None of these
- The sum of two numbers is fixed. Then its multiplication is maximum, when
(a) Each number is half of the sum
(b) Each number is $\frac{1}{3}$ and $\frac{2}{3}$ respectively of the sum
(c) Each number is $\frac{1}{4}$ and $\frac{3}{4}$ respectively of the sum
(d) None of these
- If sum of two numbers is 3, then maximum value of the product of first and the square of second is
(a) 4 (b) 3 (c) 2 (d) 1
- If from a wire of length 36 metre a rectangle of greatest area is made, then its two adjacent sides in metre are
(a) 6, 12 (b) 9, 9
(c) 10, 8 (d) 13, 5
- 20 is divided into two parts so that product of cube of one quantity and square of the other quantity is maximum. The parts are
(a) 10, 10 (b) 16, 4
(c) 8, 12 (d) 12, 8
- x and y be two variables such that $x > 0$ and $xy = 1$. Then the minimum value of $x + y$ is
(a) 2 (b) 3 (c) 4 (d) 0
- Divide 20 into two parts such that the product of one part and the cube of the other is maximum. The two parts are
(a) (10, 10) (b) (5, 15)
(c) (13, 7) (d) None of these
- The maximum and minimum values of $x^3 - 18x^2 + 96x$ in interval $(0, 9)$ are
(a) 160, 0 (b) 60, 0
(c) 160, 128 (d) 120, 28
- The maximum value of $\sin x(1 + \cos x)$ will be at the
(a) $x = \frac{\pi}{2}$ (b) $x = \frac{\pi}{6}$
(c) $x = \frac{\pi}{3}$ (d) $x = \pi$
- The function $f(x) = 2x^3 - 3x^2 - 12x + 4$ has
(a) No maxima and minima
(b) One maximum and one minimum
(c) Two maxima
(d) Two minima
- The perimeter of a sector is p . The area of the sector is maximum when its radius is
(a) $\sqrt{p}$ (b) $\frac{1}{\sqrt{p}}$
(c) $\frac{p}{2}$ (d) $\frac{p}{4}$
- The minimum value of $\left(x^2 + \frac{250}{x}\right)$ is
(a) 75 (b) 50 (c) 25 (d) 55

Answers Key

Single Correct Answer Type

- | | | | | | | | | | |
|--------|--------|--------|--------|--------|---------|---------|---------|---------|---------|
| 1. (d) | 2. (c) | 3. (c) | 4. (c) | 5. (a) | 6. (a) | 7. (b) | 8. (d) | 9. (a) | 10. (b) |
| | | | | | 11. (c) | 12. (c) | 13. (b) | 14. (d) | 15. (a) |

DPP 2.6

Application of Derivatives

Single Correct Answer Type

- A man 2 metre high walks at a uniform speed 5 metre/hour away from a lamp post 6 metre high. The rate at which the length of his shadow increases is
(a) 5 m/h (b) $\frac{5}{2}$ m/h (c) $\frac{5}{3}$ m/h (d) $\frac{5}{4}$ m/h
- A ladder 5 m in length is resting against vertical wall. The bottom of the ladder is pulled along the ground away from the wall at the rate of 1.5 m/sec. The length of the highest point of the ladder when the foot of the ladder 4.0 m away from the wall decreases at the rate of
(a) 2 m/sec (b) 3 m/sec
(c) 2.5 m/sec (d) 1.5 m/sec
- If by dropping a stone in a quiet lake a wave moves in circle at a speed of 3.5 cm/sec, then the rate of increase of the enclosed circular region when the radius of the circular wave is 10 cm, is $\left(\pi = \frac{22}{7}\right)$
(a) 220 sq. cm/sec (b) 110 sq. cm/sec
(c) 35 sq. cm/sec (d) 350 sq. cm/sec
- A ladder is resting with the wall at an angle of 30° . A man is ascending the ladder at the rate of 3 ft/sec. His rate of approaching the wall is
(a) 3 ft/sec (b) $\frac{3}{2}$ ft/sec
(c) $\frac{3}{4}$ ft/sec (d) $\frac{3}{\sqrt{2}}$ ft/sec
- If the edge of a cube increases at the rate of 60 cm per second, at what rate the volume is increasing when the edge is 90 cm
(a) 486000 cu cm per sec
(b) 1458000 cu cm per sec
(c) 43740000 cu cm per sec
(d) None of these
- If the rate of increase of area of a circle is not constant but the rate of increase of perimeter is constant, then the rate of increase of area varies
(a) As the square of the perimeter
(b) Inversely as the perimeter
(c) As the radius
(d) Inversely as the radius
- The sides of an equilateral triangle are increasing at the rate of 2 cm/sec. The rate at which the area increases, when the side is 10 cm is
(a) $\sqrt{3}$ sq. unit/sec (b) 10 sq. unit/sec
(c) $10\sqrt{3}$ sq. unit/sec (d) $\frac{10}{\sqrt{3}}$ sq. unit/sec
- A spherical iron ball 10 cm in radius is coated with a layer of ice of uniform thickness that melts at a rate of 50 cm³/min. When the thickness of ice is 5 cm, then the rate at which the thickness of ice decreases, is
(a) $\frac{1}{54\pi}$ cm/min (b) $\frac{5}{6\pi}$ cm/min
(c) $\frac{1}{36\pi}$ cm/min (d) $\frac{1}{18\pi}$ cm/min
- A spherical balloon is being inflated at the rate of 35 cc/min. The rate of increase of the surface area of the balloon when its diameter is 14 cm is
(a) 7 sq. cm/min (b) 10 sq. cm/min
(c) 17.5 sq. cm/min (d) 28 sq. cm/min
- A population $p(t)$ of 1000 bacteria introduced into nutrient medium grows according to the relation $p(t) = 1000 + \frac{1000t}{100 + t^2}$. The maximum size of this bacterial population is
(a) 1100 (b) 1250
(c) 1050 (d) 5250
- A ladder 10 m long rests against a vertical wall with the lower end on the horizontal ground. The lower end of the ladder is pulled along the ground away from the wall at the rate of 3 cm/sec. The height of the upper end while it is descending at the rate of 4 cm/sec is
(a) $4\sqrt{3}$ m (b) 6 m
(c) $5\sqrt{2}$ m (d) 8 m

Answers Key

Single Correct Answer Type

1. (b) 2. (a) 3. (a) 4. (b) 5. (b)

6. (c) 7. (c) 8. (d) 9. (b) 10. (c)
11. (b)

DPP 2.7

Basic Integration

Subjective Type

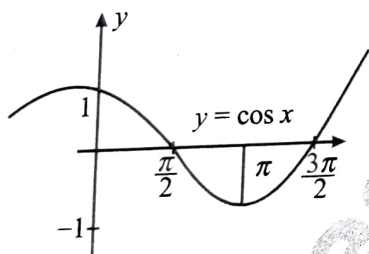
1. Integrate:

(a) $\frac{3}{2}\sqrt{x}$ (b) $\frac{3}{2\sqrt{x}}$ (c) $\sqrt{x} + \frac{1}{\sqrt{x}}$

2. Integrate the following: $\int (2t - 4)^{-4} dt$

3. Sketch the region whose area is represented by the definite integral and evaluate the integral using an appropriate formula from geometry.

(a) $\int_1^4 2dx$ (b) $\int_{-1}^2 (x+2)dx$ (c) $\int_0^2 (x-1)dx$

4. Find the area under the curve $y = \cos x$ over the interval (a) $[0, \pi/2]$ (b) $[0, \pi]$ 

Single Correct Answer Type

5. $\int \sqrt{1 + \sin x} dx =$

(a) $\frac{1}{2} \left(\sin \frac{x}{2} + \cos \frac{x}{2} \right) + c$

(b) $\frac{1}{2} \left(\sin \frac{x}{2} - \cos \frac{x}{2} \right) + c$

(c) $2\sqrt{1 + \sin x} + c$

(d) $-2\sqrt{1 - \sin x} + c$

6. $\int \left(2 \sin x + \frac{1}{x} \right) dx$ is equal to

(a) $-2 \cos x + \log x + c$ (b) $2 \cos x + \log x + c$

(c) $-2 \sin x - \frac{1}{x^2} + c$ (d) $-2 \cos x + \frac{1}{x^2} + c$

7. $\int \sqrt{1 + \cos x} dx$ equals

(a) $2\sqrt{2} \sin \frac{x}{2} + c$

(b) $-2\sqrt{2} \sin \frac{x}{2} + c$

(c) $-2\sqrt{2} \cos \frac{x}{2} + c$

(d) $2\sqrt{2} \cos \frac{x}{2} + c$

8. $\int 2 \sin x \cos x dx$ is equal to

(a) $\cos 2x + c$

(b) $-\sin 2x + c$

(c) $\cos^2 x + c$

(d) $\sin^2 x + c$

9. If $y = \sin(2x + 3)$ then $\int y dx$ will be:

(a) $\frac{\cos(2x + 3)}{2}$

(b) $-\frac{\cos(2x + 3)}{2} + C$

(c) $-\cos(2x + 3)$

(d) $-2 \cos(2x + 3)$

10. $\int 2 \sin(x) dx$ is equal to:

(a) $-2 \cos x + C$

(b) $2 \cos x + C$

(c) $-2 \cos x$

(d) $2 \cos x$

11. If $y = x^2$, then $\int_0^1 y dx$ will be:

(a) $\frac{x^3}{3} + C$

(b) $\frac{1}{3}$

(c) $\frac{2}{3}$

(d) 0

12. If $y = x^2$, then area of curve y v/s x from $x = 0$ to 2 will be:

(a) $1/3$

(b) $8/3$

(c) $4/3$

(d) $2/3$

13. Value of $\int_0^{\pi/2} \cos 3t dt$ is

(a) $\frac{2}{3}$

(b) $-\frac{1}{3}$

(c) $-\frac{2}{3}$

(d) $\frac{1}{3}$

14. $\int \left(\cos \frac{x}{2} - \sin \frac{x}{2} \right)^2 dx =$

(a) $x + \cos x + c$

(b) $2 \cos^2 \frac{x}{2} + c$

(c) $\frac{1}{3} \left(\cos \frac{x}{2} - \frac{x}{2} \right)^3 + c$

(d) $x - \cos x + c$

Comprehension Type**For Problems 15–17**

If $a = (3t^2 + 2t + 1)\text{m/s}^2$ is the expression according to which the acceleration of a particle varies. Then-

$$a = (3t^2 + 2t + 1)\text{m/s}^2$$

15. The expression for instantaneous velocity at any time ' t ' will be (if the particle was initially at rest)-
 (a) $t^3 + 2t + 1$ (b) $t^3 + t + 1$
 (c) $t^3 + t^2 + t$ (d) $t^3 + t^2 + t + C$
16. The change in velocity after 3 seconds of its start is:
 (a) 30 m/s (b) 39 m/s
 (c) 3 m/s (d) 20 m/s

17. Find displacement of the particle after 2 seconds of start.
 (a) 26 m (b) 26/3 m
 (c) 30/7 m (d) 26/7 m

Fill in the Blanks

18. $\int x^2$ is equal to...
19. $\int x^3 dx$ is equal to...
20. $\int \left(\frac{1}{5} - \frac{2}{x^3} + 2x \right) dx$ is equal to...
21. If $y = 3x^2 + 2x + 4$, then $\int y dx$ will be...
22. Find $\int \frac{dx}{dx+b}$

Answers Key**Subjective Type**

2. $= -\frac{(2t-4)^{-3}}{6} + C$
3. (a) 6 (b) $\frac{15}{2}$ (c) $-\frac{1}{2}$
4. (a) 1 (b) zero

Single Correct Answer Type

5. (d) 6. (a) 7. (a) 8. (d) 9. (b)
 10. (a) 11. (b) 12. (b) 13. (b) 14. (a)

Comprehension Type

15. (c) 16. (b) 17. (b)

Fill in the Blanks

18. Meaningless
19. $\frac{x^4}{4} + C$
20. $\frac{x}{5} + \frac{1}{x^2} + x^2 + C$
21. $x^3 + x^2 + 4x + c$
22. $\frac{1}{a} \log_e (ax+b) + C$

DPP 3.1

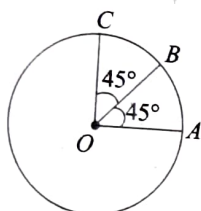
Vector Addition

Single Correct Answer Type

- Given that $\vec{A} + \vec{B} + \vec{C} = 0$ out of three vectors two are equal in magnitude and the magnitude of third vector is $\sqrt{2}$ times that of either of the two having equal magnitude. Then the angles between vectors are given by
 - $30^\circ, 60^\circ, 90^\circ$
 - $45^\circ, 45^\circ, 90^\circ$
 - $45^\circ, 60^\circ, 90^\circ$
 - $90^\circ, 135^\circ, 135^\circ$
- A boy walks uniformly along the sides of a rectangular park of size $400 \text{ m} \times 300 \text{ m}$, starting from one corner to the other corner diagonally opposite. Which of the following statement is incorrect
 - He has travelled a distance of 700 m
 - His displacement is 700 m
 - His displacement is 500 m
 - His velocity is not uniform throughout the walk
- When three forces of 50 N, 30 N and 15 N act on a body, then the body is
 - At rest
 - Moving with a uniform velocity
 - In equilibrium
 - Moving with an acceleration
- The magnitudes of vectors $\vec{A}$, $\vec{B}$ and $\vec{C}$ are 3, 4 and 5 units respectively. If $\vec{A} + \vec{B} = \vec{C}$, the angle between $\vec{A}$ and $\vec{B}$ is
 - $\frac{\pi}{2}$
 - $\cos^{-1}(0.6)$
 - $\tan^{-1}\left(\frac{7}{5}\right)$
 - $\frac{\pi}{4}$
- 100 coplanar forces each equal to 10 N act on a body. Each force makes angle $\pi/50$ with the preceding force. What is the resultant of the forces
 - 1000 N
 - 500 N
 - 250 N
 - Zero
- Five equal forces of 10 N each are applied at one point and all are lying in one plane. If the angles between them are equal, the resultant force will be
 - Zero
 - 10 N
 - 20 N
 - $10\sqrt{2}$ N
- A scooter going due east at 10 ms^{-1} turns right through an angle of 90° . If the speed of the scooter remains unchanged in taking turn, the change in the velocity of the scooter is
 - 20.0 ms^{-1} south eastern direction
 - Zero
 - 10.0 ms^{-1} in southern direction
 - 14.14 ms^{-1} in south-west direction
- A person goes 10 km north and 20 km east. What will be displacement from initial point?
 - 22.36 km
 - 2 km
 - 5 km
 - 20 km
- If the resultant of n forces of different magnitudes acting at a point is zero, then the minimum value of n is
 - 1
 - 2
 - 3
 - 4
- A force of 5 N acts on a particle along a direction making an angle of 60° with vertical. Its vertical component be
 - 10 N
 - 3 N
 - 4 N
 - 2.5 N
- y component of velocity is 20 and x component of velocity is 10. The direction of motion of the body with the horizontal at this instant is

3.2 Mechanics I

- (a) $\tan^{-1}(2)$ (b) $\tan^{-1}(1/2)$
 (c) 45° (d) 0°
12. A car travels 6 km towards north at an angle of 45° to the east and then travels distance of 4 km towards north at an angle of 135° to the east. How far is the point from the starting point? What angle does the straight line joining its initial and final position makes with the east?
- (a) $\sqrt{50}$ km and $\tan^{-1}(5)$
 (b) 10 km and $\tan^{-1}(\sqrt{5})$
 (c) $\sqrt{52}$ km and $\tan^{-1}(5)$
 (d) $\sqrt{52}$ km and $\tan^{-1}(\sqrt{5})$
13. A vector $\vec{a}$ is turned without a change in its length through a small angle $d\theta$. The value of $|\Delta\vec{a}|$ and Δa are respectively
- (a) 0, $a d\theta$ (b) $a d\theta$, 0
 (c) 0, 0 (d) None of these
14. Find the resultant of three vectors $\vec{OA}$, $\vec{OB}$ and $\vec{OC}$ shown in the following figure. Radius of the circle is R .



- (a) $2R$ (b) $R(1 + \sqrt{2})$
 (c) $R\sqrt{2}$ (d) $R(\sqrt{2} - 1)$

Matching Column Type

15. In list I some straight lines graphs are given and in list II corresponding signs of slopes and intercepts are given. Match the type of graphs of list I corresponding to signs of slopes and intercepts in list II

List I	List II
(A)	(i) 30° East of North
(B)	(ii) 30° North of East
(C)	(iii) 30° west of North
(D)	(iv) 60° South of West

Answers Key

Single Correct Answer Type

1. (d) 2. (b) 3. (d) 4. (a) 5. (d)
 6. (a) 7. (d) 8. (a) 9. (c) 10. (d)

11. (a) 12. (c) 13. (b) 14. (b)

Matching Column Type

15. (A $\rightarrow$ ii), (B $\rightarrow$ iii), (C $\rightarrow$ i), (D $\rightarrow$ iv)

DPP 3.2

Resultant of Vectors

Single Correct Answer Type

- Two forces, each of magnitude F have a resultant of the same magnitude F . The angle between the two forces is
(a) 45° (b) 120° (c) 150° (d) 60°
- The resultant of $\vec{A} + \vec{B}$ is $\vec{R}_1$. On reversing the vector $\vec{B}$ the resultant becomes $\vec{R}_2$. What is the value of $R_1^2 + R_2^2$?
(a) $A^2 + B^2$ (b) $A^2 - B^2$
(c) $2(A^2 + B^2)$ (d) $2(A^2 - B^2)$
- Forces F_1 and F_2 act on a point mass in two mutually perpendicular directions. The resultant force on the point mass will be
(a) $F_1 + F_2$ (b) $F_1 - F_2$
(c) $\sqrt{F_1^2 + F_2^2}$ (d) $F_1^2 + F_2^2$
- The sum of two forces acting at a point is 16 N. If the resultant force is 8 N and its direction is perpendicular to minimum force then the forces are
(a) 6 N and 10 N (b) 8 N and 8 N
(c) 4 N and 12 N (d) 2 N and 14 N
- If vectors P , Q and R have magnitude 5, 12 and 13 units and $\vec{P} + \vec{Q} = \vec{R}$, the angle between Q and R is
(a) $\cos^{-1} \frac{5}{12}$ (b) $\cos^{-1} \frac{5}{13}$
(c) $\cos^{-1} \frac{12}{13}$ (d) $\cos^{-1} \frac{7}{13}$
- The resultant of two vectors A and B is perpendicular to the vector A and its magnitude is equal to half the magnitude of vector B . The angle between A and B is
(a) 120° (b) 150°
(c) 135° (d) None of these
- The resultant of $\vec{P}$ and $\vec{Q}$ is perpendicular to $\vec{P}$. What is the angle between $\vec{P}$ and $\vec{Q}$?
(a) $\cos^{-1} (P/Q)$ (b) $\cos^{-1} (-P/Q)$
(c) $\sin^{-1} (P/Q)$ (d) $\sin^{-1} (-P/Q)$

- If the sum of two unit vectors is a unit vector, then magnitude of difference is
(a) $\sqrt{2}$ (b) $\sqrt{3}$
(c) $1/\sqrt{2}$ (d) $\sqrt{5}$
- Maximum and minimum magnitudes of the resultant of two vectors of magnitudes P and Q are in the ratio 3:1. Which of the following relations is true?
(a) $P = 2Q$ (b) $P = Q$
(c) $PQ = 1$ (d) None of these
- Two forces 3 N and 2 N are at an angle θ such that the resultant is R . The first force is now increased to 6 N and the resultant become $2R$. The value of θ is
(a) 30° (b) 60° (c) 90° (d) 120°
- If $|\vec{A} + \vec{B}| = |\vec{A}| + |\vec{B}|$, then angle between $\vec{A}$ and $\vec{B}$ will be
(a) 90° (b) 120°
(c) 0° (d) 60°
- The maximum and minimum magnitude of the resultant of two given vectors are 17 units and 7 unit respectively. If these two vectors are at right angles to each other, the magnitude of their resultant is
(a) 14 (b) 16 (c) 18 (d) 13
- Two equal forces (P each) act at a point inclined to each other at an angle of 120° . The magnitude of their resultant is
(a) $P/2$ (b) $P/4$ (c) P (d) $2P$
- The sum of the magnitudes of two forces acting at point is 18 and the magnitude of their resultant is 12. If the resultant is at 90° with the force of smaller magnitude, what are the magnitudes of forces?
(a) 12, 5 (b) 14, 4 (c) 5, 13 (d) 10, 8
- Three forces P , Q and R are acting on a particle in the plane, the angle between P and Q & Q and R are 150° and 120° respectively. Then for equilibrium, forces P , Q and R are in the ratio
(a) 1 : 2 : 3 (b) 1 : 2 : $\sqrt{3}$
(c) 3 : 2 : 1 (d) $\sqrt{3}$: 2 : 1

Answers Key

Single Correct Answer Type

- | | | | | | | | | | |
|--------|--------|--------|--------|--------|---------|---------|---------|---------|---------|
| 1. (b) | 2. (c) | 3. (c) | 4. (a) | 5. (c) | 6. (b) | 7. (b) | 8. (b) | 9. (a) | 10. (d) |
| | | | | | 11. (c) | 12. (d) | 13. (c) | 14. (c) | 15. (d) |

DPP 3.3

Expression of Vectors

Single Correct Answer Type

- If a particle moves from point $P(2,3,5)$ to point $Q(3,4,5)$. Its displacement vector be
 (a) $\hat{i} + \hat{j} + 10\hat{k}$ (b) $\hat{i} + \hat{j} + 5\hat{k}$
 (c) $\hat{i} + \hat{j}$ (d) $2\hat{i} + 4\hat{j} + 6\hat{k}$
- $\vec{A} = 2\hat{i} + \hat{j}$, $\vec{B} = 3\hat{j} - \hat{k}$ and $\vec{C} = 6\hat{i} - 2\hat{k}$.
 Value of $\vec{A} - 2\vec{B} + 3\vec{C}$ would be
 (a) $20\hat{i} + 5\hat{j} + 4\hat{k}$ (b) $20\hat{i} - 5\hat{j} - 4\hat{k}$
 (c) $4\hat{i} + 5\hat{j} + 20\hat{k}$ (d) $5\hat{i} + 4\hat{j} + 10\hat{k}$
- Two forces $F_1 = 1\text{ N}$ and $F_2 = 2\text{ N}$ act along the lines $x = 0$ and $y = 0$ respectively. Then the resultant of forces would be
 (a) $\hat{i} + 2\hat{j}$ (b) $\hat{i} + \hat{j}$
 (c) $3\hat{i} + 2\hat{j}$ (d) $2\hat{i} + \hat{j}$
- Following forces start acting on a particle at rest at the origin of the co-ordinate system simultaneously
 $\vec{F}_1 = -4\hat{i} - 5\hat{j} + 5\hat{k}$, $\vec{F}_2 = 5\hat{i} + 8\hat{j} + 6\hat{k}$, $\vec{F}_3 = -3\hat{i} + 4\hat{j} - 7\hat{k}$
 and $\vec{F}_4 = 2\hat{i} - 3\hat{j} - 2\hat{k}$ then the particle will move
 (a) In x - y plane (b) In y - z plane
 (c) In x - z plane (d) Along x -axis
- A body is at rest under the action of three forces, two of which are $\vec{F}_1 = 4\hat{i}$, $\vec{F}_2 = 6\hat{j}$, the third force is
 (a) $4\hat{i} + 6\hat{j}$ (b) $4\hat{i} - 6\hat{j}$
 (c) $-4\hat{i} + 6\hat{j}$ (d) $-4\hat{i} - 6\hat{j}$
- The vector that must be added to the vector $\hat{i} - 3\hat{j} + 2\hat{k}$ and $3\hat{i} + 6\hat{j} - 7\hat{k}$ so that the resultant vector is a unit vector along the y -axis is
 (a) $4\hat{i} + 2\hat{j} + 5\hat{k}$ (b) $-4\hat{i} - 2\hat{j} + 5\hat{k}$
 (c) $3\hat{i} + 4\hat{j} + 5\hat{k}$ (d) Null vector
- If $A = 3\hat{i} + 4\hat{j}$ and $B = 7\hat{i} + 24\hat{j}$, the vector having the same magnitude as B and parallel to A is
 (a) $5\hat{i} + 20\hat{j}$ (b) $15\hat{i} + 10\hat{j}$
 (c) $20\hat{i} + 15\hat{j}$ (d) $15\hat{i} + 20\hat{j}$
- The unit vector parallel to the resultant of the vectors $\vec{A} = 4\hat{i} + 3\hat{j} + 6\hat{k}$ and $\vec{B} = -\hat{i} + 3\hat{j} - 8\hat{k}$ is
 (a) $\frac{1}{7}(3\hat{i} + 6\hat{j} - 2\hat{k})$ (b) $\frac{1}{7}(3\hat{i} + 6\hat{j} + 2\hat{k})$
 (c) $\frac{1}{49}(3\hat{i} + 6\hat{j} - 2\hat{k})$ (d) $\frac{1}{49}(3\hat{i} - 6\hat{j} + 2\hat{k})$
- The position vector of a particle is determined by the expression $\vec{r} = 3t^2\hat{i} + 4t^2\hat{j} + 7\hat{k}$
 The distance traversed in first 10 sec is
 (a) 500 m (b) 300 m
 (c) 150 m (d) 100 m
- Unit vector parallel to the resultant of vectors $\vec{A} = 4\hat{i} - 3\hat{j}$ and $\vec{B} = 8\hat{i} + 8\hat{j}$ will be
 (a) $\frac{24\hat{i} + 5\hat{j}}{13}$ (b) $\frac{12\hat{i} + 5\hat{j}}{13}$
 (c) $\frac{6\hat{i} + 5\hat{j}}{13}$ (d) None of these
- The three vectors $\vec{A} = 3\hat{i} - 2\hat{j} + \hat{k}$, $\vec{B} = \hat{i} - 3\hat{j} + 5\hat{k}$ and $\vec{C} = 2\hat{i} + \hat{j} - 4\hat{k}$ form
 (a) An equilateral triangle
 (b) Isosceles triangle
 (c) A right angled triangle
 (d) No triangle
- A person moves 30 m north and then 20 m towards east and finally $30\sqrt{2}$ m in south-west direction. The displacement of the person from the origin will be
 (a) 10 m along north (b) 10 m long south
 (c) 10 m along west (d) Zero

Answers Key

Single Correct Answer Type

1. (c) 2. (b) 3. (d) 4. (b) 5. (d) 6. (b) 7. (d) 8. (a) 9. (a) 10. (b)
11. (c) 12. (c)

DPP 3.4

Dot Product

Single Correct Answer Type

- The angles which a vector $\hat{i} + \hat{j} + \sqrt{2}\hat{k}$ makes with X, Y and Z axes respectively are
(a) $60^\circ, 60^\circ, 60^\circ$ (b) $45^\circ, 45^\circ, 45^\circ$
(c) $60^\circ, 60^\circ, 45^\circ$ (d) $45^\circ, 45^\circ, 60^\circ$
- If a vector $\vec{P}$ making angles α, β , and γ respectively with the X, Y and Z axes respectively. Then $\sin^2 \alpha + \sin^2 \beta + \sin^2 \gamma =$
(a) 0 (b) 1 (c) 2 (d) 3
- If two vectors $2\hat{i} + 3\hat{j} - \hat{k}$ and $-4\hat{i} - 6\hat{j} - \lambda\hat{k}$ are parallel to each other, then value of λ will be
(a) 0 (b) 2 (c) 3 (d) 4
- The angle between the two vectors $\vec{A} = 3\hat{i} + 4\hat{j} + 5\hat{k}$ and $\vec{B} = 3\hat{i} + 4\hat{j} - 5\hat{k}$ will be
(a) 90° (b) 0° (c) 60° (d) 45°
- If a vector $2\hat{i} + 3\hat{j} + 8\hat{k}$ is perpendicular to the vector $4\hat{j} - 4\hat{i} + \alpha\hat{k}$. Then the value of α is
(a) -1 (b) $\frac{1}{2}$ (c) $-\frac{1}{2}$ (d) 1
- If for two vector $\vec{A}$ and $\vec{B}$, sum $(\vec{A} + \vec{B})$ is perpendicular to the difference $(\vec{A} - \vec{B})$. The ratio of their magnitude is
(a) 1 (b) 2
(c) 3 (d) None of these
- Consider a vector $\vec{F} = 4\hat{i} - 3\hat{j}$. Another vector that is perpendicular to $\vec{F}$ is
(a) $4\hat{i} + 3\hat{j}$ (b) $6\hat{i}$
(c) $7\hat{k}$ (d) $3\hat{i} - 4\hat{j}$
- If $|\vec{V}_1 + \vec{V}_2| = |\vec{V}_1 - \vec{V}_2|$ and V_2 is finite, then
(a) V_1 is parallel to V_2
(b) $\vec{V}_1 = \vec{V}_2$
(c) V_1 and V_2 are mutually perpendicular
(d) $|\vec{V}_1| = |\vec{V}_2|$
- The angle between the vectors $(\hat{i} + \hat{j})$ and $(\hat{j} + \hat{k})$ is
(a) 30° (b) 45° (c) 60° (d) 90°
- If $\vec{P} \cdot \vec{Q} = PQ$, then angle between $\vec{P}$ and $\vec{Q}$ is
(a) 0° (b) 30° (c) 45° (d) 60°
- A particle moves in the x-y plane under the action of a force $\vec{F}$ such that the value of its linear momentum ($\vec{P}$) at anytime t is $P_x = 2 \cos t, p_y = 2 \sin t$. The angle θ between $\vec{F}$ and $\vec{P}$ at a given time t will be
(a) $\theta = 0^\circ$ (b) $\theta = 30^\circ$
(c) $\theta = 90^\circ$ (d) $\theta = 180^\circ$
- The position vectors of points A, B, C and D are $A = 3\hat{i} + 4\hat{j} + 5\hat{k}, B = 4\hat{i} + 5\hat{j} + 6\hat{k}, C = 7\hat{i} + 9\hat{j} + 3\hat{k}$, and $D = 4\hat{i} + 6\hat{j}$, then the displacement vectors AB and CD are
(a) Perpendicular (b) Parallel
(c) Antiparallel (d) Inclined at an angle of 60°
- When $\vec{A} \cdot \vec{B} = -|\vec{A}| |\vec{B}|$ then
(a) $\vec{A}$ and $\vec{B}$ are perpendicular to each other
(b) $\vec{A}$ and $\vec{B}$ act in the same direction
(c) $\vec{A}$ and $\vec{B}$ act in the opposite direction
(d) $\vec{A}$ and $\vec{B}$ can act in any direction
- The component of vector $A = 2\hat{i} + 3\hat{j}$ along the vector $\hat{i} + \hat{j}$ is
(a) $\frac{5}{\sqrt{2}}$ (b) $10\sqrt{2}$ (c) $5\sqrt{2}$ (d) 5

Answers Key

Single Correct Answer Type

- | | | | | | | | | | |
|--------|--------|--------|--------|--------|---------|---------|---------|---------|---------|
| 1. (c) | 2. (c) | 3. (b) | 4. (a) | 5. (c) | 6. (a) | 7. (c) | 8. (c) | 9. (c) | 10. (a) |
| | | | | | 11. (c) | 12. (d) | 13. (c) | 14. (a) | |

DPP 3.5

Cross Product

Single Correct Answer Type

- If a vector $\vec{A}$ is parallel to another vector $\vec{B}$, then the resultant of the vector $\vec{A} \times \vec{B}$ will be equal to
 - A
 - $\vec{A}$
 - Zero vector
 - Zero
- If $\vec{A} = 3\hat{i} + \hat{j} + 2\hat{k}$ and $\vec{B} = 2\hat{i} - 2\hat{j} + 4\hat{k}$, then value of $|\vec{A} \times \vec{B}|$ will be
 - $8\sqrt{2}$
 - $8\sqrt{3}$
 - $8\sqrt{5}$
 - $5\sqrt{8}$
- Which of the following is the unit vector perpendicular to $\vec{A}$ and $\vec{B}$?
 - $\frac{\vec{A} \times \vec{B}}{AB \sin \theta}$
 - $\frac{\vec{A} \times \vec{B}}{AB \cos \theta}$
 - $\frac{\vec{A} \times \vec{B}}{AB \sin \theta}$
 - $\frac{\vec{A} \times \vec{B}}{AB \cos \theta}$
- If $\vec{A} \times \vec{B} = \vec{C}$, then which of the following statements is wrong
 - $\vec{C} \perp \vec{A}$
 - $\vec{C} \perp \vec{B}$
 - $\vec{C} \perp (\vec{A} + \vec{B})$
 - $\vec{C} \perp (\vec{A} \times \vec{B})$
- The angle between the vectors $\vec{A}$ and $\vec{B}$ is θ . The value of the triple product $\vec{A} \cdot (\vec{B} \times \vec{A})$ is
 - $A^2 B$
 - Zero
 - $A^2 B \sin \theta$
 - $A^2 B \cos \theta$
- If $\vec{A} \times \vec{B} = \vec{B} \times \vec{A}$, then the angle between A and B is
 - $\pi/2$
 - $\pi/3$
 - π
 - $\pi/4$
- The angle between vectors $(\vec{A} \times \vec{B})$ and $(\vec{B} \times \vec{A})$ is
 - Zero
 - π
 - $\pi/4$
 - $\pi/2$
- A vector $\vec{A}$ points vertically upward and $\vec{B}$ points towards north. The vector product $\vec{A} \times \vec{B}$ is
 - Zero
 - Along east
 - Along west
 - Vertically downward
- Two vector A and B have equal magnitudes. Then the vector $A + B$ is perpendicular to
 - $A \times B$
 - $A - B$
 - $3A - 3B$
 - All of these
- The value of $(\vec{A} + \vec{B}) \times (\vec{A} - \vec{B})$ is
 - 0
 - $A^2 - B^2$
 - $\vec{B} \times \vec{A}$
 - $2(\vec{B} \times \vec{A})$
- The linear velocity of a rotating body is given by $\vec{v} = \vec{\omega} \times \vec{r}$, where $\vec{\omega}$ is the angular velocity and $\vec{r}$ is the radius vector. The angular velocity of a body is $\vec{\omega} = \hat{i} - 2\hat{j} + 2\hat{k}$ and the radius vector $\vec{r} = 4\hat{j} - 3\hat{k}$, then $|\vec{v}|$ is
 - $\sqrt{29}$ units
 - $\sqrt{31}$ units
 - $\sqrt{37}$ units
 - $\sqrt{41}$ units
- Two adjacent sides of a parallelogram are represented by the two vectors $\hat{i} + 2\hat{j} + 3\hat{k}$ and $3\hat{i} - 2\hat{j} + \hat{k}$. What is the area of parallelogram?
 - 8
 - $8\sqrt{3}$
 - $3\sqrt{8}$
 - 192
- The vectors from origin to the points A and B are $\vec{A} = 3\hat{i} - 6\hat{j} + 2\hat{k}$ and $\vec{B} = 2\hat{i} + \hat{j} - 2\hat{k}$ respectively. The area of the triangle OAB be
 - $\frac{5}{2}\sqrt{17}$ sq. units
 - $\frac{2}{5}\sqrt{17}$ sq. units
 - $\frac{3}{5}\sqrt{17}$ sq. units
 - $\frac{5}{3}\sqrt{17}$ sq. units
- If $|\vec{A} \times \vec{B}| = \sqrt{3}\vec{A} \cdot \vec{B}$, then the value of $|\vec{A} + \vec{B}|$ is
 - $\left(A^2 + B^2 + \frac{AB}{\sqrt{3}}\right)^{1/2}$
 - $A + B$
 - $(A^2 + B^2 + \sqrt{3}AB)^{1/2}$
 - $(A^2 + B^2 + AB)^{1/2}$

Answers Key

Single Correct Answer Type

1. (c) 2. (b) 3. (c) 4. (d) 5. (b)

6. (c) 7. (b) 8. (b) 9. (a) 10. (d)
11. (a) 12. (b) 13. (a) 14. (d)

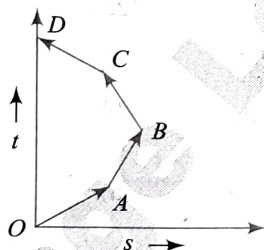
Motion in One Dimension

DPP 4.1

General Kinematics 1

Single Correct Answer Type

- The ratio of the numerical values of the average velocity and average speed of a body is always
 - Unity
 - Unity or less
 - Unity or more
 - Less than unity
- Which of the following options is correct for the object having a straight line motion represented by the following graph?



- The object moves with constantly increasing velocity from O to A and then it moves with constant velocity.
 - Velocity of the object increases uniformly
 - Average velocity is zero
 - The graph shown is impossible
- The numerical ratio of displacement to the distance covered is always
 - Less than one
 - Equal to one
 - Equal to or less than one
 - Equal to or greater than one

- A particle moves along a straight line path. After some time it comes to rest. The motion is with constant acceleration whose direction with respect to the direction of velocity is:
 - positive throughout motion
 - negative throughout motion
 - first positive then negative
 - first negative then positive
- If a car covers $2/5^{\text{th}}$ of the total distance with v_1 speed and $3/5^{\text{th}}$ distance with v_2 , then average speed is

(a) $\frac{1}{2}\sqrt{v_1 v_2}$	(b) $\frac{v_1 + v_2}{2}$
(c) $\frac{2v_1 v_2}{v_1 + v_2}$	(d) $\frac{5v_1 v_2}{3v_1 + 2v_2}$
- One car moving on a straight road covers one-third of the distance with 20 km/hr and the rest with 60 km/hr. The average speed is

(a) 40 km/hr	(b) 80 km/hr
(c) $46\frac{2}{3}$ km/hr	(d) 36 km/hr
- A man walks on a straight road from his home to a market 2.5 km away with a speed of 5 km/h. Finding the market closed, he instantly turns and walks back home with a speed of 7.5 km/h. The average speed of the man over the interval of time 0 to 40 min is equal to

(a) 5 km/h	(b) $\frac{25}{4}$ km/h
(c) $\frac{30}{4}$ km/h	(d) $\frac{45}{8}$ km/h

4.2 Mechanics I

8. Consider the acceleration, velocity and displacement of a tennis ball as it falls to the ground and bounces back. Directions of which of these changes in the process
- Velocity only
 - Displacement and velocity
 - Acceleration, velocity and displacement
 - Displacement and acceleration
9. The position of a particle moving in the xy -plane at any time t is given by $x = (3t^2 - 6t)$ metres, $y = (t^2 - 2t)$ metres. Select the correct statement about the moving particle from the following
- The acceleration of the particle is zero at $t = 0$ second
 - The velocity of the particle is zero at $t = 0$ second
 - The velocity of the particle is zero at $t = 1$ second
 - The velocity and acceleration of the particle are never zero
10. The acceleration ' a ' in m/s^2 of a particle is given by $a = 3t^2 + 2t + 2$ where t is the time. If the particle starts out with a velocity $u = 2 \text{ m/s}$ at $t = 0$, then the velocity at the end of 2 second is
- 12 m/s
 - 18 m/s
 - 27 m/s
 - 36 m/s
11. The x and y coordinates of a particle at any time t are given by $x = 7t + 4t^2$ and $y = 5t$, where x and y are in metre and t in seconds. The acceleration of particle at $t = 5 \text{ s}$ is
- Zero
 - 8 m/s^2
 - 20 m/s^2
 - 40 m/s^2

Multiple Correct Answers Type

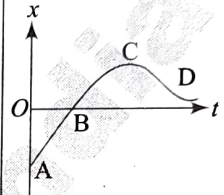
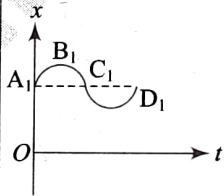
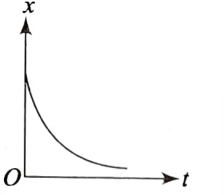
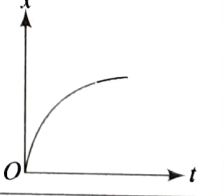
12. Which of the following four statements are correct?
- A body can have zero velocity and still be accelerated
 - A body can have a constant velocity and still have a varying speed
 - A body can have a constant speed and still have a varying velocity
 - The direction of the velocity of a body can change when its acceleration is constant
13. A particle is moving on the x -axis. If initial velocity $u > 0$, and acceleration $a < 0$ and a is constant then number

of possible values of the time for which the particle is at distance ' d ' from its starting point may be:

- One
 - Two
 - Three
 - Four
14. For a particle moving in straight line with increasing speed the appropriate sign of acceleration a and velocity v can be:
- $a > 0$ and $v > 0$
 - $a < 0$ and $v < 0$
 - $a > 0$ and $v < 0$
 - $a < 0$ and $v > 0$

Matching Column Type

15. Refer to the graph in figure. Match the following

Column I		Column II	
(A)		(p)	Has $v > 0$ and $a > 0$ throughout
(B)		(q)	has $x > 0$ throughout and has a point with $v = 0$ and appoint with $a = 0$
(C)		(r)	has a point with zero displacement for $t > 0$
(D)		(s)	has $v < 0$ and $a > 0$

Answers Key

Single Correct Answer Type

1. (b) 2. (c) 3. (c) 4. (b) 5. (d)
 6. (d) 7. (d) 8. (b) 9. (c) 10. (b)
 11. (b)

Multiple Correct Answers Type

12. (a, c, d) 13. (a, b, c) 14. (a, b)

Matching Column Type

15. (A $\rightarrow$ r), (B $\rightarrow$ q), (C $\rightarrow$ s), (D $\rightarrow$ p),

DPP 4.2

General Kinematics 2

Subjective Type

1. A radius vector of point A relative to the origin varies with time t as $\vec{r} = at\hat{i} - bt^2\hat{j}$ where a and b are constants. Find the equation of point's trajectory.
2. The speed of a body moving on a straight track varies according to $v = \frac{4}{5}t^2 + 3$ for $0 < t < 5$ sec and $v = 3t + 8$ for $t > 5$ sec. If distances are in meters, find the distance moved by a particle at the end of 10 sec.

Single Correct Answer Type

3. The acceleration of a particle is increasing linearly with time t as bt . The particle starts from the origin with an initial velocity v_0 . The distance travelled by the particle in time t will be
 - (a) $v_0t + \frac{1}{3}bt^2$
 - (b) $v_0t + \frac{1}{3}bt^3$
 - (c) $v_0t + \frac{1}{6}bt^3$
 - (d) $v_0t + \frac{1}{2}bt^2$
4. A body starts from the origin and moves along the X-axis such that the velocity at any instant is given by $(4t^3 - 2t)$, where t is in sec and velocity in m/s. What is the acceleration of the particle, when it is 2 m from the origin?
 - (a) 28 m/s²
 - (b) 22 m/s²
 - (c) 12 m/s²
 - (d) 10 m/s²
5. The relation between time and distance is $t = \alpha x^2 + \beta x$, where α and β are constants. The retardation is
 - (a) $2\alpha v^3$
 - (b) $2\beta v^3$
 - (c) $2\alpha\beta v^3$
 - (d) $2\beta^2 v^3$
6. The relation $3t = \sqrt{3x} + 6$ describes the displacement of a particle in one direction where x is in metres and t in sec. The displacement, when velocity is zero, is
 - (a) 24 metres
 - (b) 12 metres
 - (c) 5 metres
 - (d) Zero
7. If the velocity of a particle is given by $v = (180 - 16x)^{1/2}$ m/s, then its acceleration will be
 - (a) Zero
 - (b) 8 m/s²
 - (c) -8 m/s²
 - (d) 4 m/s²

8. A particle moves along x-axis as

$$x = 4(t - 2) + a(t - 2)^2$$

Which of the following is true?

- (a) The initial velocity of particle is 4
 - (b) The acceleration of particle is $2a$
 - (c) The particle is at origin at $t = 0$
 - (d) None of these
9. The position vector of a particle is given as $\vec{r} = (t^2 - 4t + 6)\hat{i} + (t^2)\hat{j}$. The time after which the velocity vector and acceleration vector becomes perpendicular to each other is equal to
 - (a) 1 sec
 - (b) 2 sec
 - (c) 1.5 sec
 - (d) not possible

Multiple Correct Answers Type

10. A particle of mass m moves along a curve $y = x^2$. When particle has x-co-ordinate as $1/2$ m and x-component of velocity as 4 m/s, then
 - (a) the position coordinate of particle are $(1/2, 1/4)$ m
 - (b) the velocity of particle will be along the line $4x - 4y - 1 = 0$.
 - (c) the magnitude of velocity at that instant is $4\sqrt{2}$ m/s
 - (d) the magnitude of velocity at that instant is $2\sqrt{2}$ m/s
11. The velocity of a particle moving in the positive direction of x-axis varies as $v = 10\sqrt{x}$. Assuming that at $t = 0$, particle was at $x = 0$.
 - (a) The initial velocity of the particle is zero.
 - (b) The initial velocity of the particle is 2.5 m/s.
 - (c) The acceleration of the particle is 2.5 m/s².
 - (d) The acceleration of the particle is 50 m/s².
12. A particle moves along x-axis such that its position varies with time as $x = 50t - 5t^2$. Select the correct alternative(s).
 - (a) The particle has travelled 130 m distance by $t = 6$ s.
 - (b) At $t = 4$ s and $t = 12$ s, the particle is at 120 m distance from starting point.
 - (c) The particle will never be at a distance of 130 m from starting point.
 - (d) During the whole motion, the particle does not have same velocity at 2 different instants.

Answers Key

Subjective Type

1. $y = -\frac{b}{a^2}x^2$
2. $\left(\frac{145}{3} + \frac{305}{2}\right)$ m

Single Correct Answer Type

3. (c)
4. (b)
5. (a)
6. (d)
7. (c)
8. (b)
9. (a)

Multiple Correct Answers Type

10. (a, b, c)
11. (a, d)
12. (a, b, d)

DPP 4.3

Motion with Constant Acceleration

Subjective Type

1. A particle moving along a straight line with a constant acceleration of -4 m/s^2 passes through a point A on the line with a velocity of $+8 \text{ m/s}$ at some moment. Find the distance travelled by the particle in 5 seconds after that moment.
2. A driver having a definite reaction time is capable of stopping his car over a distance of 30 m on seeing a red traffic signal, when the speed of the car is 72 km/hr and over a distance of 10 m when the speed is 36 km/hr. Find the distance over which he can stop the car if it were running at a speed of 54 km/hr. Assume that his reaction time and the deceleration of the car remains same in all the three cases.

Single Correct Answer Type

3. A particle experiences a constant acceleration for 20 sec after starting from rest. If it travels a distance S_1 in the first 10 sec and a distance S_2 in the next 10 sec, then
 - (a) $S_1 = S_2$
 - (b) $S_1 = S_2/3$
 - (c) $S_1 = S_2/2$
 - (d) $S_1 = S_2/4$
4. A body is moving from rest under constant acceleration and let S_1 be the displacement in the first $(p-1)$ sec and S_2 be the displacement in the first p sec. The displacement in $(p^2 - p + 1)^{\text{th}}$ sec will be
 - (a) $S_1 + S_2$
 - (b) $S_1 S_2$
 - (c) $S_1 - S_2$
 - (d) S_1/S_2
5. A particle travels 10 m in first 5 sec and 10 m in next 3 sec. Assuming constant acceleration what is the distance travelled in next 2 sec
 - (a) 8.3 m
 - (b) 9.3 m
 - (c) 10.3 m
 - (d) None of above
6. A particle starts from rest, accelerates at 2 m/s^2 for 10 s and then goes for constant speed for 30 s and then decelerates at 4 m/s^2 till it stops. What is the distance travelled by it?
 - (a) 750 m
 - (b) 800 m
 - (c) 700 m
 - (d) 850 m

7. A car starts from rest and moves with uniform acceleration a on a straight road from time $t = 0$ to $t = T$. After that, a constant deceleration brings it to rest. In this process the average speed of the car is

- (a) $\frac{aT}{4}$
- (b) $\frac{3aT}{2}$
- (c) $\frac{aT}{2}$
- (d) aT

8. A body is moving with uniform acceleration describes 40 m in the first 5 sec and 65 m in next 5 sec. Its initial velocity will be

- (a) 4 m/s
- (b) 2.5 m/s
- (c) 5.5 m/s
- (d) 11 m/s

9. A car, starting from rest, accelerates at the rate f through a distance S , then continues at constant speed for time t and then decelerates at the rate $\frac{f}{2}$ to come to rest. If the total distance traversed is $15S$, then

- (a) $S = \frac{1}{2}ft^2$
- (b) $S = \frac{1}{4}ft^2$
- (c) $S = \frac{1}{72}ft^2$
- (d) $S = \frac{1}{6}ft^2$

10. A man is 45 m behind the bus when the bus start accelerating from rest with acceleration 2.5 m/s^2 . With what minimum velocity should the man start running to catch the bus?

- (a) 12 m/s
- (b) 14 m/s
- (c) 15 m/s
- (d) 16 m/s

11. A car A is travelling on a straight level road with a uniform speed of 60 km/h. It is followed by another car B which is moving with a speed of 70 km/h. When the distance between them is 2.5 km, the car B is given a deceleration of 20 km/h^2 . After how much time will B catch up with A

- (a) 1 hr
- (b) 1/2 hr
- (c) 1/4 hr
- (d) 1/8 hr

12. The speed of a body moving with uniform acceleration is u . This speed is doubled while covering a distance S . When it covers an additional distance S , its speed would become

- (a) $\sqrt{3}u$
- (b) $\sqrt{5}u$
- (c) $\sqrt{11}u$
- (d) $\sqrt{7}u$

Answers Key

Subjective Type

1. 26 m.
2. 18.75 m

Single Correct Answer Type

3. (b)
4. (a)
5. (a)
6. (a)
7. (c)
8. (c)
9. (c)
10. (c)
11. (b)
12. (d)

DPP 4.4

Motion Under Gravity

Single Correct Answer Type

- A body is released from the top of a tower of height h . It takes t sec to reach the ground. Where will be the ball after time $t/2$ sec?
 - At $h/2$ from the ground
 - At $h/4$ from the ground
 - Depends upon mass and volume of the body
 - At $3h/4$ from the ground
- A ball is projected upwards from a height h above the surface of the earth with velocity v . The time at which the ball strikes the ground is

$$(a) \frac{v}{g} + \frac{2hg}{\sqrt{2}} \quad (b) \frac{v}{g} \left[1 - \sqrt{1 + \frac{2h}{g}} \right]$$

$$(c) \frac{v}{g} \left[1 + \sqrt{1 + \frac{2gh}{v^2}} \right] \quad (d) \frac{v}{g} \left[1 + \sqrt{v^2 + \frac{2g}{h}} \right]$$

- A body is projected vertically up with a velocity v and after some time it returns to the point from which it was projected. The average velocity and average speed of the body for the total time of flight are
 - $\bar{v}/2$ and $v/2$
 - 0 and $v/2$
 - 0 and 0
 - $\bar{v}/2$ and 0
- Two bodies are thrown simultaneously from a tower with same initial velocity v_0 : one vertically upwards, the other vertically downwards. The distance between the two bodies after time t is
 - $2v_0t + \frac{1}{2}gt^2$
 - $2v_0t$
 - $v_0t + \frac{1}{2}gt^2$
 - v_0t
- A body falling from a high Minaret travels 40 meters in the last 2 seconds of its fall to ground. Height of Minaret in meters is (take $g = 10 \text{ m/s}^2$)
 - 60
 - 45
 - 80
 - 50
- A man drops a ball downside from the roof of a tower of height 400 meters. At the same time another ball is thrown upside with a velocity 50 meter/sec from the surface of the tower, then they will meet at which height from the surface of the tower
 - 100 meters
 - 320 meters
 - 80 meters
 - 240 meters

- If a freely falling body travels in the last second, a distance equal to the distance travelled by it in the first three second, the time of the travel is
 - 6 sec
 - 5 sec
 - 4 sec
 - 3 sec
- A body is projected up with a speed ' u ' and the time taken by it is T to reach the maximum height H . Pick out the correct statement
 - It reaches $H/2$ in $T/2$ sec
 - It acquires velocity $u/2$ in $T/2$ sec
 - Its velocity is $u/2$ at $H/2$
 - Same velocity at $2T$
- A body freely falling from the rest has a velocity ' v ' after it falls through a height ' h '. The distance it has to fall down for its velocity to become double, is
 - $2h$
 - $4h$
 - $6h$
 - $8h$
- A man throws balls with the same speed vertically upwards one after the other at an interval of 2 seconds. What should be the speed of the throw so that more than two balls are in the sky at any time (Given $g = 10 \text{ m/s}^2$)
 - At least 0.8 m/s
 - Any speed less than 20 m/s
 - Only with speed 20 m/s
 - More than 20 m/s

Multiple Correct Answers Type

- A stone is projected vertically upwards at $t = 0$ second. The net displacement of stone is zero in time interval between $t = 0$ second to $t = T$ seconds. Pick up the CORRECT statement.
 - From time $t = \frac{T}{4}$ second to $t = \frac{3T}{4}$ second, the average velocity is zero.
 - The change in velocity from time $t = 0$ to $t = \frac{T}{4}$ second is same as change in velocity from $t = \frac{T}{8}$ second to $t = \frac{3T}{8}$ second
 - The distance travelled from $t = 0$ to $t = \frac{T}{4}$ second is larger than distance travelled from $t = \frac{T}{4}$ second to $t = \frac{3T}{4}$ second

- (d) The distance travelled from $t = \frac{T}{2}$ second to $t = \frac{3T}{4}$ second is half the distance travelled from $t = \frac{T}{2}$ second to $t = T$ second.

12. A person, standing on the roof of a 40 m high tower, throws a ball vertically upwards with speed 10 m/s. Two seconds later, he throws another ball again in vertical direction (use $g = 10 \text{ m/s}^2$). Both the balls hit the ground simultaneously.
- The first ball hits the ground after 4 seconds.
 - The second ball was projected vertically downwards with speed 5 m/s.
 - The distance travelled by the first ball is 10 m greater than the distance travelled by the second ball.
 - Both balls hit the ground with same velocities.
13. A balloon starts rising from the ground with an acceleration of 1.25 ms^{-2} . After 8 seconds, a stone is released from the balloon. After releasing, the stone will:

- cover a distance of 50 m till it strikes the ground.
- have a displacement of 50 m till it reaches the ground.
- reach the ground in 4 seconds.
- begin to move down instantaneously.

Comprehension Type

A man is standing on top of a building 100 m high. He throws two balls vertically, one at $t = 0$ and after a time interval (less than 2 seconds). The later ball is thrown at a velocity of half the first. At $t = 2\text{ s}$, both the balls reach to their maximum heights. At this time the vertical gap between first and second ball is + 15 m.

14. The speed of first ball is
- 20 m/s
 - 10 m/s
 - 5 m/s
 - 15 m/s
15. The time interval between the throw of balls is
- 1.2 sec
 - 0.5 sec
 - 0.8 sec
 - 1 sec

Answers Key

Single Correct Answer Type

- | | | | | |
|--------|--------|--------|--------|---------|
| 1. (d) | 2. (c) | 3. (b) | 4. (b) | 5. (b) |
| 6. (c) | 7. (b) | 8. (b) | 9. (b) | 10. (d) |

Multiple Correct Answers Type

11. (a, b, c) 12. (a, c, d) 13. (a, c)

Comprehension Type

14. (a) 15. (d)

DPP 4.5

Relative Motion in One Dimension

Single Correct Answer Type

- A 120 m long train is moving in a direction with speed 20 m/s. A train B moving with 30 m/s in the opposite direction and 130 m long crosses the first train in a time
 - 6 s
 - 36 s
 - 38 s
 - None of these
- A 210 meter long train is moving due North at a of 25 m/s. A small bird is flying due South a little above the train with speed 5 m/s. The time taken by the bird to cross the train is
 - 6 s
 - 7 s
 - 9 s
 - 10 s
- A police jeep is chasing with, velocity of 45 km/h, a thief in another jeep moving with velocity 153 km/h. Police fires a bullet with muzzle velocity of 180 m/s. The velocity it will strike the car of the thief is
 - 150 m/s
 - 27 m/s
 - 450 m/s
 - 250 m/s
- The distance between two particles is decreasing at the rate of 6 m/sec. If these particles travel with same speeds and in the same direction, then the separation increase at the rate of 4 m/sec. The particles have speeds as
 - 5 m/sec; 1 m/sec
 - 4 m/sec; 1 m/sec
 - 4 m/sec; 2 m/sec
 - 5 m/sec; 2 m/sec
- A boat moves with a speed of 5 km/h relative to water in a river flowing with a speed of 3 km/h and having a width of 1 km. The minimum time taken around a round trip is
 - 5 min
 - 60 min
 - 20 min
 - 30 min
- An express train is moving with a velocity v_1 . Its driver finds another train is moving on the same track in the same direction with velocity v_2 . To escape collision, driver applies a retardation a on the train. The minimum time of escaping collision will be
 - $t = \frac{v_1 - v_2}{a}$
 - $t_1 = \frac{v_1^2 - v_2^2}{2}$
 - None
 - Both
- A thief is running away on a straight road in jeep moving with a speed of 9 ms^{-1} . A police man chases him on a motor cycle moving at a speed of 10 ms^{-1} . If the instantaneous separation of the jeep from the motorcycle is 100 m, how long will it take for the police to catch the thief

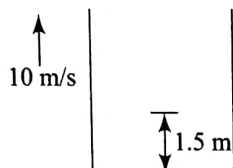
- 1 s
 - 19 s
 - 90 s
 - 100 s
- Two trains one of length 100 m and another of length 125 m, are moving in mutually opposite directions along parallel lines, meet each other, each with speed 10 m/s. If their acceleration are 0.3 m/s^2 and 0.2 m/s^2 respectively, then the time they take to pass each other will be
 - 5 s
 - 10 s
 - 15 s
 - 20 s
 - Two cars are moving in the same direction with the same speed 30 km/hr. They are separated by a distance of 5 km, the speed of a car moving in the opposite direction if it meets these two cars at an interval of 4 minutes, will be
 - 40 km/hr
 - 45 km/hr
 - 30 km/hr
 - 15 km/hr
 - A boat takes two hours to travel 8 km and back in still water. If the velocity of water is 4 km/h, the time taken for going upstream 8 km and coming back is
 - 2h
 - 2h 40 min
 - 1h 20 min
 - Cannot be estimated with the information given

Multiple Correct Answers Type

- A man in a lift ascending with an upward acceleration 'a' throws a ball vertically upwards with a velocity 'v' with respect to himself and catches it after ' t_1 ' seconds. Afterwards when the lift is descending with the same acceleration 'a' acting downwards the man again throws the ball vertically upwards with the same velocity with respect to him and catches it after ' t_2 ' seconds?
 - the acceleration of the ball w.r.t. ground is g when it is in air
 - the velocity v of the ball relative to the lift is $\frac{g(t_1 + t_2)}{t_1 t_2}$
 - the acceleration 'a' of the lift is $\frac{g(t_2 - t_1)}{t_1 + t_2}$
 - the velocity 'v' of the ball relative to the man is $\frac{g t_1 t_2}{(t_1 + t_2)}$

Comprehension Type

A boy in the elevator shoots a bullet in a vertical upward direction from a height of 1.5 m above the floor of the elevator. There is no roof in the elevator. The floor of the elevator is at 50 m from ground at the instant when velocity of the elevator is 10 m/s in upward direction. The bullet strikes the floor of the elevator in 2 seconds. The initial speed of the bullet is 15 m/s relative to the elevator.



12. Find the acceleration of the elevator in upward direction, (m/s^2):
(a) 5 (b) 5.25 (c) 5.75 (d) 6.25
13. Find the displacement of the bullet relative to ground during its flight:
(a) 50.0 m (b) 40 m
(c) 25 m (d) 30 m
14. Find the maximum height reached by the bullet relative to the ground:
(a) 85 m (b) 82 m
(c) 82.75 m (d) 85.25 m
15. Find the distance travelled by bullet during its flight:
(a) 32.0 m (b) 30.0 m
(c) 50.0 m (d) 35.0 m

Answers Key**Single Correct Answer Type**

- | | | | | |
|--------|--------|--------|--------|---------|
| 1. (d) | 2. (b) | 3. (a) | 4. (a) | 5. (d) |
| 6. (a) | 7. (d) | 8. (b) | 9. (b) | 10. (b) |

Multiple Correct Answers Type

11. (a, c, d)

Comprehension Type

12. (a) 13. (d) 14. (c) 15. (a)

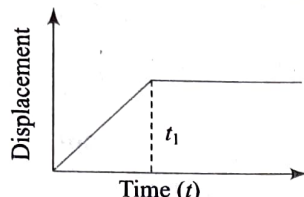
DPP 4.6

Understanding Motion Through Graph

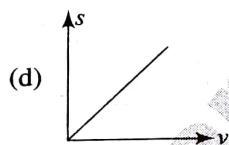
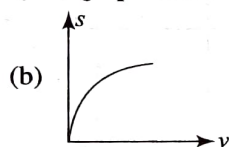
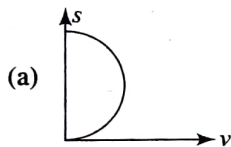
Single Correct Answer Type

1. The $x-t$ graph shown in figure represents

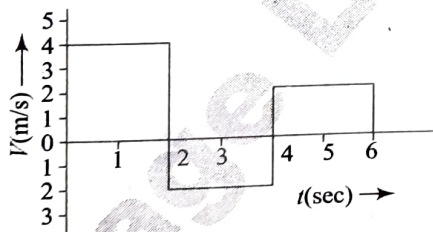
- (a) Constant velocity
(b) Velocity of the body is continuously changing
(c) Instantaneous velocity
(d) The body travels with constant speed upto time t_1 and then stops



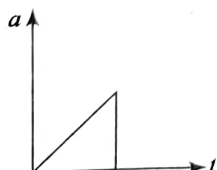
2. An object is moving with a uniform acceleration which is parallel to its instantaneous direction of motion. The displacement (s) and velocity (v) graph of this object is



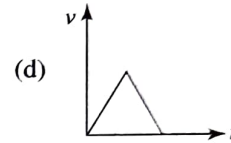
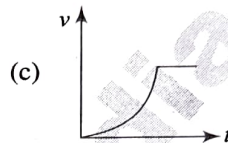
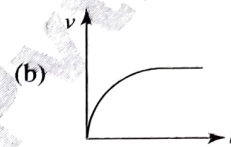
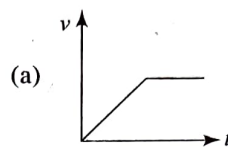
3. The velocity-time graph of a body moving in a straight line is shown in the figure. The displacement and distance travelled by the body in 6 sec are respectively



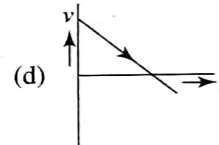
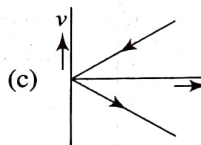
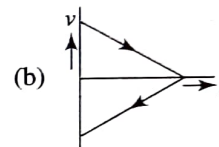
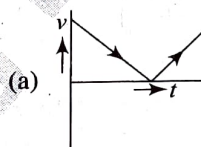
- (a) 8 m, 16 m
(b) 16 m, 8 m
(c) 16 m, 16 m
(d) 8 m, 8 m
4. The acceleration-time graph of a body is shown below



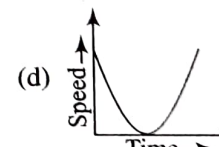
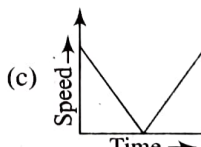
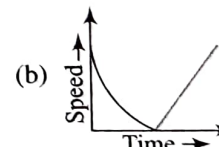
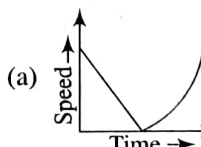
The most probable velocity-time graph of the body is



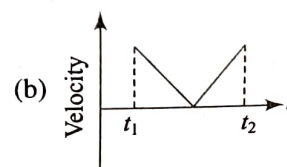
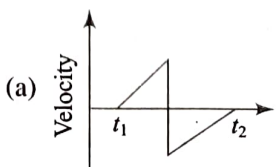
5. A ball is thrown vertically upwards. Which of the following graph/graphs represent velocity-time graph of the ball during its flight (air resistance is neglected).

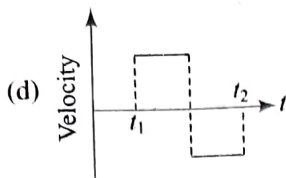
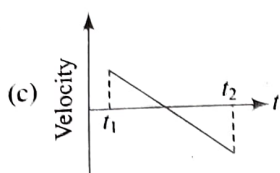


6. A ball is thrown vertically upwards. Which of the following plots represents the speed-time graph of the ball during its height if the air resistance is not ignored?

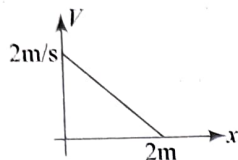


7. A batsman hits a sixer and the ball touches the ground outside the cricket ground. Which of the following graph describes the variation of the cricket ball's vertical velocity v with time between the time t_1 as it hits the bat and time t_2 when it touches the ground?

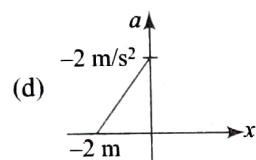
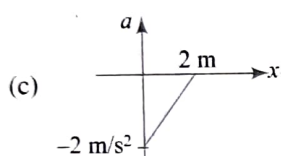
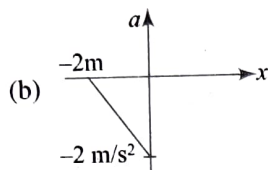
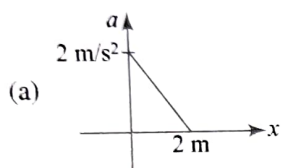




8. The velocity displacement graph of a particle moving along a straight line is shown in figure.

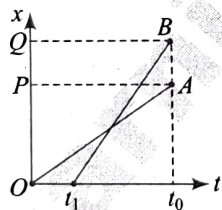


Then the acceleration displacement graph is.



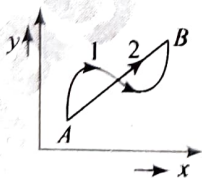
Multiple Correct Answers Type

9. The position-time ($x-t$) graphs for two children A and B returning from their school O to their homes P and Q respectively along straight line path (taken as x -axis) are shown in figure.



Choose the correct statement (s):

- (a) A lives closer to the school than B
 (b) A starts from the school earlier than B
 (c) A and B have equal average velocities from 0 to t_0 .
 (d) B overtakes A on the way
10. A particle can travel from point A to B from two different paths 1 and 2, as shown, in same interval of time. Then which of the following is incorrect?



- (a) Average velocity along the two paths must be equal
 (b) The particle may travel along both the paths unaccelerated
 (c) The direction of instantaneous velocity along the path 1 and 2 can be same for a maximum of two point on the paths.
 (d) The average and instantaneous velocity along path 1 can have same direction.

Matching Column Type

11. In each of the situations assume that particle was initially at rest at origin and there after it moved rectilinearly. Some of the graph in left column represent the same motion as represented by graphs in right column match these graphs.

Column I		Column II	
(A)		(p)	
(B)		(q)	
(C)		(r)	
(D)		(s)	

Answers Key

Single Correct Answer Type

1. (d) 2. (c) 3. (a) 4. (c) 5. (d)
 6. (c) 7. (c) 8. (c)

Multiple Correct Answers Type

9. (a, b, d) 10. (a, c, d)

Matching Column Type

11. (A $\rightarrow$ r), (B $\rightarrow$ q), (C $\rightarrow$ s), (D $\rightarrow$ p)

Motion in Two Dimensions

DPP 5.1

Projectile 1

Single Correct Answer Type

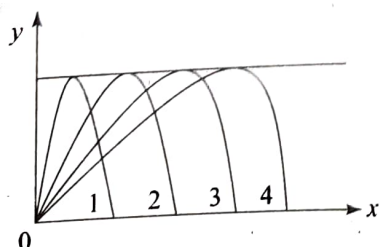
1. A body of mass m is thrown upwards at an angle θ with the horizontal with velocity v . While rising up the velocity of the mass after t seconds will be

- (a) $\sqrt{(v \cos \theta)^2 + (v \sin \theta)^2}$
 (b) $\sqrt{(v \cos \theta - v \sin \theta)^2 - gt}$
 (c) $\sqrt{v^2 + g^2 t^2 - (2v \sin \theta) gt}$
 (d) $\sqrt{v^2 + g^2 t^2 - (2v \cos \theta) gt}$

2. Velocity of a stone projected, 2 second before it reaches the maximum height, makes angle 53° with the horizontal then the velocity at highest point will be

- (a) 20 m/s (b) 15 m/s
 (c) 25 m/s (d) 80/3 m/s

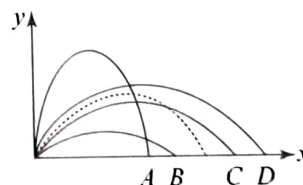
3. Figure shows four paths for a kicked football. Ignoring the effects of air on the flight, rank the paths according to initial horizontal velocity component, highest first



- (a) 1, 2, 3, 4 (b) 2, 3, 4, 1
 (c) 3, 4, 1, 2 (d) 4, 3, 2, 1

4. Four bodies P, Q, R and S are projected with equal velocities having angles of projection $15^\circ, 30^\circ, 45^\circ$ and 60° with the horizontal respectively. The body having shortest range is
 (a) P (b) Q (c) R (d) S

5. The path of a projectile in the absence of air drag is shown in the figure by dotted line. If the air resistance is not ignored then which one of the path shown in the figure is appropriate for the projectile



- (a) B (b) A (c) D (d) C
 6. A stone projected with a velocity u at an angle θ with the horizontal reaches maximum height H_1 . When it is projected with velocity u at an angle $\left(\frac{\pi}{2} - \theta\right)$ with the horizontal, it reaches maximum height H_2 . The relation between the horizontal range R of the projectile H_1 and H_2 is

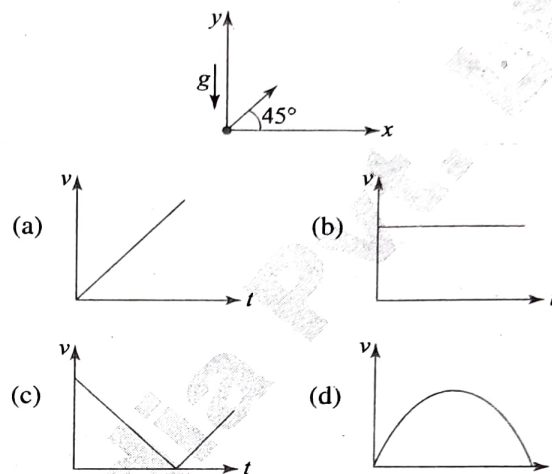
- (a) $R = 4\sqrt{H_1 H_2}$ (b) $R = 4(H_1 - H_2)$
 (c) $R = 4(H_1 + H_2)$ (d) $R = \frac{H_1^2}{H_2^2}$

7. An object is projected with a velocity of 20 m/s making an angle of 45° with horizontal. The equation for the trajectory is $h = Ax - Bx^2$ where h is height, x is horizontal distance, A and B are constants. The ratio $A : B$ is ($g = 10 \text{ ms}^{-2}$)
 (a) 1 : 5 (b) 5 : 1
 (c) 1 : 40 (d) 40 : 1
8. For a given velocity, a projectile has the same range R for two angles of projection if t_1 and t_2 are the times of flight in the two cases then
 (a) $t_1 t_2 \propto R^2$ (b) $t_1 t_2 \propto R$
 (c) $t_1 t_2 \propto \frac{1}{R}$ (d) $t_1 t_2 \propto \frac{1}{R^2}$
9. A stone is projected from the ground with velocity 50 m/s at an angle of 30° . It crosses a wall after 3 sec. How far beyond the wall the stone will strike the ground ($g = 10 \text{ m/sec}^2$)?
 (a) 90.2 m (b) 89.6 m
 (c) 86.6 m (d) 70.2 m
10. A particle is projected with a velocity v such that its range on the horizontal plane is twice the greatest height attained by it. The range of the projectile is (where g is acceleration due to gravity)
 (a) $\frac{4v^2}{5g}$ (b) $\frac{4g}{5v^2}$
 (c) $\frac{v^2}{g}$ (d) $\frac{4v^2}{\sqrt{5}g}$
11. A man standing on the roof of a house of height h throws one particle vertically downwards and another particle horizontally with the same velocity u . The ratio of their velocities when they reach the earth's surface will be
 (a) $\sqrt{2gh + u^2} : u$ (b) 1 : 2
 (c) 1 : 1 (d) $\sqrt{2gh + u^2} : \sqrt{2gh}$

Multiple Correct Answers Type

12. At the highest point of the path of a projectile, its
 (a) speed is zero
 (b) speed is minimum
 (c) Kinetic energy is minimum
 (d) Potential energy is maximum
13. A stone is projected at an angle 45° with horizontal above horizontal x -axis as shown in figure (and y -axis is vertical). Four graphs representing the magnitude of horizontal (v_x)

or magnitude of vertical (v_y) component of velocity of stone w.r.t. time t as shown. Then which of the following magnitude of velocity versus time graph best represents v_x versus t and v_y versus t respectively for the stone.



Comprehension Type

A stone is projected from level ground with speed u and at an angle θ with horizontal. Somehow the acceleration due to gravity (g) becomes double (that is $2g$) immediately after the stone reaches the maximum height and remains same thereafter. Assume direction of acceleration due to gravity always vertically downwards.

14. The total time of flight of particle is:

(a) $\frac{3u \sin \theta}{2g}$ (b) $\frac{u \sin \theta}{g} \left(1 + \frac{1}{\sqrt{2}}\right)$
 (c) $\frac{2u \sin \theta}{g}$ (d) $\frac{u \sin \theta}{g} \left(2 + \frac{1}{\sqrt{2}}\right)$

15. The horizontal range of particle is

(a) $\frac{3u^2 \sin 2\theta}{4g}$ (b) $\frac{u^2 \sin 2\theta}{2g} \left(1 + \frac{1}{\sqrt{2}}\right)$
 (c) $\frac{u^2}{g} \sin 2\theta$ (d) $\frac{u^2 \sin 2\theta}{2g} \left(2 + \frac{1}{\sqrt{2}}\right)$

16. The angle ϕ which the velocity vector of stone makes with horizontal just before hitting the ground is given by:

(a) $\tan \phi = 2 \tan \theta$ (b) $\tan \phi = 2 \cot \theta$
 (c) $\tan \phi = \sqrt{2} \tan \theta$ (d) $\tan \phi = \sqrt{2} \cos \theta$

Answers Key

Single Correct Answer Type

1. (c) 2. (b) 3. (d) 4. (a) 5. (a)
 6. (a) 7. (d) 8. (b) 9. (c) 10. (a)
 11. (c)

Multiple Correct Answers Type

12. (b, c, d) 13. (b, c)

Comprehension Type

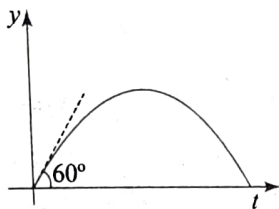
14. (b) 15. (b) 16. (c)

DPP 5.2

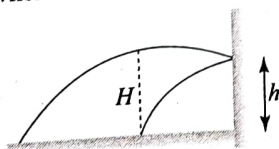
Projectile 2

Single Correct Answer Type

1. A particle is projected from the horizontal x - z plane, in vertical x - y plane where x -axis is horizontal and positive y -axis vertically upwards. The graph of ' y ' coordinate of the particle v/s time is as shown. The range of the particle is $\sqrt{3}$. Then the speed of the projected particle is:

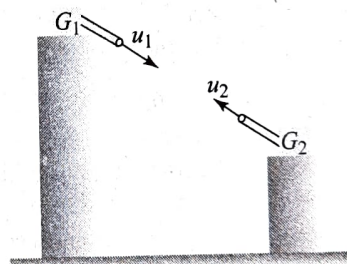


- (a) $\sqrt{3}$ m/s (b) $\sqrt{\frac{403}{4}}$ m/s
(c) $2\sqrt{5}$ m/s (d) $\sqrt{28}$ m/s
2. A particle is projected from a point (0, 1) on Y -axis (assume + Y direction vertically upwards) aiming towards a point (4, 9). It fell on ground along x axis in 1 sec. Taking $g = 10 \text{ m/s}^2$ and all coordinate in metres. Find the X -coordinate where it fell.
- (a) (3, 0) (b) (4, 0)
(c) (2, 0) (d) $(2\sqrt{5}, 0)$
3. A particle at a height ' h ' from the ground is projected with an angle 30° from the horizontal, it strikes the ground making angle 45° with horizontal. It is again projected from the same point with the same speed but with an angle of 60° with horizontal. Find the angle it makes with the horizontal when it strikes the ground:
- (a) $\tan^{-1}(4)$ (b) $\tan^{-1}(5)$
(c) $\tan^{-1}(\sqrt{5})$ (d) $\tan^{-1}(\sqrt{3})$
4. A stone is projected from a horizontal plane. It attains maximum height ' H ' & strikes a stationary smooth wall & falls on the ground vertically below the maximum height. Assuming the collision to be elastic the height of the point on the wall where ball will strike is



- (a) $\frac{H}{2}$ (b) $\frac{H}{4}$
(c) $\frac{3H}{4}$ (d) None of these

5. A projectile A is projected from ground. An observer B running on ground with uniform velocity of magnitude ' v ' observes A to move along a straight line. The time of flight of A as measured by B is T . Then the range R of projectile on ground is
- (a) $R = vT$
(b) $R < vT$
(c) $R > vT$
(d) information insufficient to draw inference
6. Two guns are mounted (fixed) on two vertical cliffs that are very high from the ground as shown in figure. The muzzle velocity of the shell from G_1 is u_1 and that from G_2 is u_2 . The guns aim exactly towards each other. The ratio $u_1 : u_2$ such that the shells collide with each other in air is (Assume that there is no resistance of air)



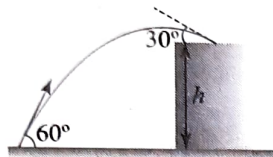
- (a) 1 : 2
(b) 1 : 4
(c) will not collide for any ratio
(d) will collide for any ratio
7. Two particles are projected from the same point with the same speed at different angles θ_1 & θ_2 to the horizontal. They have the same range. Their times of flight are t_1 & t_2 respectively.
- (a) $\frac{t_1}{t_2} = \tan^2 \theta_1$ (b) $\frac{t_1}{\sin \theta_1} = \frac{t_2}{\cos \theta_2}$
(c) $\frac{t_1}{t_2} = \tan \theta_1$ (d) $\frac{t_1}{t_2} = \tan^2 \theta_2$
8. Three stones A, B and C are simultaneously projected from same point with same speed. A is thrown upwards,

5.4 Mechanics I

B is thrown horizontally and C is thrown downwards from a building. When the distance between stone A and C becomes 10 m, then distance between A and B will be –

- (a) 10 m (b) 5 m (c) $5\sqrt{2}$ m (d) $10\sqrt{2}$ m

9. A stone projected at an angle of 60° from the ground level strikes at an angle of 30° on the roof of a building of height 'h'. Then the speed of projection of the stone is:

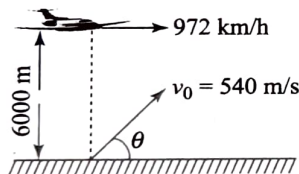


- (a) $\sqrt{2gh}$ (b) $\sqrt{6gh}$
(c) $\sqrt{3gh}$ (d) $\sqrt{gh}$

10. A bullet is fired from horizontal ground at some angle passes through the point, where 'R' is the range of the bullet. Assume point of the fire to be origin and the bullet moves in x-y plane with x-axis horizontal and y-axis vertically upwards. Then angle of projection is

- (a) 30° (b) 37° (c) 53° (d) none

11. An aircraft moving with a speed of 1000 km/h is at a height of 6000 m, just overhead of an anti-aircraft gun. If the muzzle velocity of the gun is 540 m/s, the firing angle θ for the bullet to hit the aircraft should be



- (a) 73° (b) 30° (c) 60° (d) 45°

12. A stone is projected from level ground such that its horizontal and vertical components of initial velocity are $u_x = 10$ m/s and $u_y = 20$ m/s respectively. Then the angle between velocity vector of stone one second before and one second after it attains maximum height is:

- (a) 30° (b) 45° (c) 60° (d) 90°

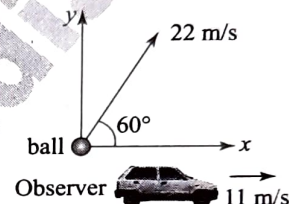
13. In the climax of a movie, the hero jumps from a helicopter and the villain chasing the hero also jumps from the same level. After sometime when they come at same horizontal level, the villain fires bullet horizontally towards the

hero. Both were falling with constant acceleration 2 m/s^2 , because of parachute. Assuming the hero to be within the range of bullet, which of the following is correct.

- (a) bullet will hit the hero
(b) bullet will pass above the hero
(c) bullet will pass below the hero
(d) bullet will definitely hit the hero, if both were falling with constant acceleration 'g' instead of 2 m/s^2

Multiple Correct Answers Type

14. A football is kicked with a speed of 22 m/s at an angle of 60° to the positive x direction taken along horizontal. At that instant, an observer moves past the football in a car that moves with a constant speed of 11 m/s in the positive x direction. Take +ve y direction vertically upwards. ($g = 10 \text{ m/s}^2$)



- (a) The initial velocity of the ball relative to the observer in the car is $11\sqrt{3}$ m/s in the +y direction
(b) The initial velocity of the ball relative to the observer in the car is 17 m/s at 60° to the +x direction.
(c) According to the observer in the car, the ball will follow a path that is straight up and down in the y direction.
(d) According to the observer in the car, the ball will follow a straight line that is angled (less than 90°) with respect to the observer.
15. A particle is projected from a horizontal floor with speed 10 m/s at an angle 30° with the floor and striking the floor after sometime. State which is correct.
- (a) Velocity of particle will be perpendicular to initial direction two seconds after projection.
(b) Minimum speed of particle will be $5\sqrt{3}$ m/sec.
(c) Displacement of particle after half second will be $\frac{1}{4}\sqrt{235}$ m
(d) The particle will strike the floor at 2 sec.

Answers Key

Single Correct Answer Type

1. (d) 2. (c) 3. (c) 4. (c) 5. (a)
6. (d) 7. (c) 8. (c) 9. (c) 10. (c)
11. (c) 12. (d) 13. (c)

Multiple Correct Answers Type

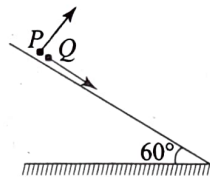
14. (a, c) 15. (b, c)

DPP 5.3

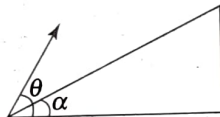
Projectile 3

Single Correct Answer Type

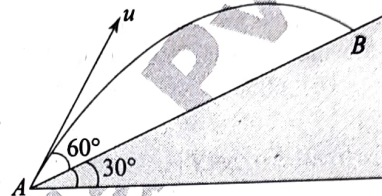
1. A particle P is projected from a point on the surface of smooth inclined plane (see figure). Simultaneously another particle Q is released on the smooth inclined plane from the same position. P and Q collide after $t = 4$ second. The speed of projection of P is



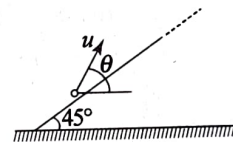
- (a) 5 m/s (b) 10 m/s
(c) 15 m/s (d) 20 m/s
2. A projectile is fired at an angle θ with the horizontal. Find the condition under which it lands perpendicular on an inclined plane inclination α as shown in figure.



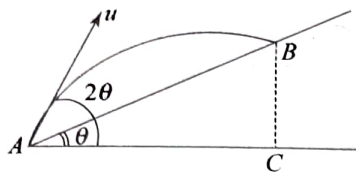
- (a) $\sin \alpha = \cos(\theta - \alpha)$
(b) $\cos \alpha = \sin(\theta - \alpha)$
(c) $\tan \theta = \cot(\theta - \alpha)$
(d) $\cot(\theta - \alpha) = 2 \tan \alpha$
3. A ball is projected with velocity u at right angle to the slope which is inclined at an angle α with the horizontal. The distance ' x ' along the inclined plane that it will travel before again striking the slope is-
- (a) $\frac{2u^2}{g} \cos \alpha$ (b) $\frac{2u^2}{g} \tan \alpha$
(c) $\frac{2u^2 \tan \alpha}{g \cos \alpha}$ (d) $\frac{2u^2 \tan \alpha}{g \sin \alpha}$
4. A stone is projected from point A with speed u making an angle 60° with horizontal as shown. The fixed inclined surface makes an angle 30° with horizontal. The stone lands at B after time t . Then the distance AB is equal to



- (a) $\frac{ut}{\sqrt{3}}$ (b) $\frac{\sqrt{3}ut}{2}$
(c) $\sqrt{3}ut$ (d) $2ut$
5. A particle is projected from surface of the inclined plane with speed u and at an angle θ with the horizontal. After some time the particle collides elastically with the smooth fixed inclined plane for the first time and subsequently moves in vertical direction. Starting from projection, find the time taken by the particle to reach maximum height. (Neglect time of collision).



- (a) $\frac{2u \cos \theta}{g}$ (b) $\frac{2u \sin \theta}{g}$
(c) $\frac{u(\sin \theta + \cos \theta)}{g}$ (d) $\frac{2u}{g}$
6. A particle is projected from a point $P(2, 0, 0)$ m with a velocity 10 m/s making an angle 45° with the horizontal. The plane of projectile motion passes through a horizontal line PQ which makes an angle of 37° with positive x -axis, xy plane is horizontal. The coordinates of the point where the particle will strike the line PQ is
- (a) (10, 6, 0) m (b) (8, 6, 0) m
(c) (10, 8, 0) m (d) (6, 10, 0) m
7. A particle is projected from point A on plane AB , so that $AB = \frac{2u^2 \tan \theta}{g\sqrt{3}}$ in the figure as shown. If u is the velocity of projection, find angle θ :



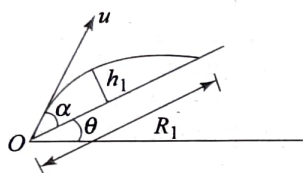
- (a) 30° (b) 60° (c) 90° (d) 45°

8. On an inclined plane two particles A and B are projected with same speed at the same angle with the horizontal, particle A down and particle B up the plane. If the ratio of time of flight of A and B is $\cot \theta$, where θ is the angle at which B is projected measured from inclined plane, find the angle at which particles are projected:

- (a) 90° (b) 60° (c) 30° (d) 45°

Multiple Correct Answers Type

9. Two balls are thrown from an inclined plane at angle of projection α with the plane one up the incline plane and other down the incline as shown in the figure. If R_1 & R_2 be their respective ranges, then:



- (a) $h_1 = h_2$ (b) $R_2 - R_1 = T_1^2$
 (c) $R_2 - R_1 = g \sin \theta T_2^2$ (d) $R_2 - R_1 = g \sin \theta T_1^2$
 [here T_1 & T_2 are times of flight in the two cases respectively]

Matching Column Type

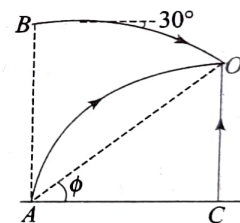
10. In the column-I, the path of a projectile (initial velocity 10 m/s and angle of projection with horizontal 60° in all cases) is shown in different cases. R angle ' R ' is to be matched in each case from column-II. Take $g = 10 \text{ m/s}^2$. Arrow on the trajectory indicates the direction of motion of projectile.

Column I		Column II	
(A)		(p)	$R = \frac{3\sqrt{3}}{2} \text{ m}$

(B)		(q)	$R = \frac{40}{3} \text{ m}$
(C)		(r)	$R = 5\sqrt{3} \text{ m}$
(D)		(s)	$R = \frac{20}{3} \text{ m}$

Comprehension Type

Points A and C are on the horizontal ground and A and B are in same vertical plane at a distance of 1500 m. Simultaneously bullets are fired from A, B and C and they collide at O. The bullet at B is fired at an angle of 30° with horizontal towards the ground at velocity 100 m/s. The bullet at C is projected vertically upward at velocity of 100 m/s. The bullet projected from A reaches its maximum height at O.



11. Find the time in which bullets will collide (seconds):
 (a) 10 (b) 15 (c) 20 (d) 25
 12. Find the elevation angle $\angle \theta = \angle OAC$:
 (a) 60° (b) 45° (c) 30° (d) 15°
 13. Find the velocity of bullet at A:
 (a) 50 m/s (b) $50\sqrt{7} \text{ m/s}$
 (c) $60\sqrt{7} \text{ m/s}$ (d) 60 m/s

Answers Key

Single Correct Answer Type

1. (b) 2. (d) 3. (a) 4. (a) 5. (c)
 6. (a) 7. (a) 8. (d)

Multiple Correct Answers Type

9. (a, c, d)

Matching Column Type

10. (A $\rightarrow$ r) (B $\rightarrow$ p) (C $\rightarrow$ s) (D $\rightarrow$ q)

Comprehension Type

11. (a) 12. (c) 13. (b)

DPP 5.4

Relative Velocity 1

Subjective Type

1. A boy throws a ball in air at 60° to the horizontal along a road with a speed of 10 m/s (36 km/h). Another boy sitting in a passing by car observes the ball. Sketch the motion of the ball as observed by the boy in the car, if car has a speed of (18 km/h). Give explanation to support your diagram.
2. A girl riding a bicycle with a speed of 5 m/s towards north direction, observes rain falling vertically down. If she increases her speed to 10 m/s, rain appears to meet her at 45° to the vertical. What is the speed of the rain? In what direction does rain fall as observed by a ground-based observer?

Single Correct Answer Type

3. A river is flowing from east to west at a speed of 5 m/min. A man on south bank of river, capable of swimming 10 m/min in still water, wants to swim across the river in shortest time. He should swim
 - (a) Due north
 - (b) Due north-east
 - (c) Due north-east with double the speed of river
 - (d) None of these
4. A person aiming to reach the exactly opposite point on the bank of a stream is swimming with a speed of 0.5 m/s at an angle of 120° with the direction of flow of water. The speed of water in the stream is
 - (a) 1 m/s
 - (b) 0.5 m/s
 - (c) 0.25 m/s
 - (d) 0.433 m/s
5. A boat crosses a river with a velocity of 8 km/h. If the resulting velocity of boat is 10 km/h then the velocity of river water is
 - (a) 4 km/h
 - (b) 6 km/h
 - (c) 8 km/h
 - (d) 10 km/h
6. A man sitting in a bus travelling in a direction from west to east with a speed of 40 km/h observes that the rain drops

are falling vertically down. To the another man standing on ground the rain will appear

- (a) To fall vertically down
 - (b) To fall at an angle going from west to east
 - (c) To fall at an angle going from east to west
 - (d) The information given is insufficient to decide the direction of rain.
7. A boat is rowed across a river at the rate of 4.5 km/hr. The river flows at the rate of 6 km/hr. The velocity of boat in m/s is:
 - (a) 3.1
 - (b) 2.1
 - (c) 2.9
 - (d) 5
 8. A swimmer crosses the river along the line making an angle of 45° with the direction of flow. Velocity of the river water is 5 m/s. Swimmer takes 12 seconds to cross the river of width 60 m. The velocity of the swimmer with respect to water will be:
 - (a) 10 m/s
 - (b) 5 m/s
 - (c) $5\sqrt{5}$ m/s
 - (d) $5\sqrt{2}$ m/s
 9. A jet airplane travelling from east to west at a speed of 500 km h⁻¹ ejected out gases of combustion at a speed of 1500 km h⁻¹ with respect to the jet plane. What is the velocity of the gases with respect to an observer on the ground?
 - (a) 1000 km h⁻¹ in the direction west to east
 - (b) 1000 km h⁻¹ in the direction east to west
 - (c) 2000 km h⁻¹ in the direction west to east
 - (d) 2000 km h⁻¹ in the direction east to west
 10. Rain is falling vertically with a velocity of 3 kmh⁻¹. A man walks in the rain with a velocity of 4 kmh⁻¹. The rain drops will fall on the man with a velocity of
 - (a) 5 kmh⁻¹
 - (b) 4 kmh⁻¹
 - (c) 3 kmh⁻¹
 - (d) 1 kmh⁻¹
 11. A man who can swim at the rate of 2 km/hr (in still river) crosses a river to a point exactly opposite on the other bank by swimming in a direction of 120° to the flow of the water in the river. The velocity of the water current in km/hr is
 - (a) 1
 - (b) 2
 - (c) 1/2
 - (d) 3/2

Answers Key

Subjective Type

1. Only vertical motion of the ball will be seen by the boy in the car
2. $5\sqrt{2}$ m/s; 45° to the vertical

Single Correct Answer Type

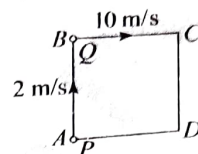
- | | | | | |
|--------|--------|---------|---------|--------|
| 3. (a) | 4. (c) | 5. (b) | 6. (b) | 7. (b) |
| 8. (b) | 9. (b) | 10. (a) | 11. (a) | |

DPP 5.5

Relative Velocity 2

Single Correct Answer Type

- An aeroplane is to go along straight line from A to B, and back again. The relative speed with respect to wind is V . The wind blows perpendicular to line AB with speed v . The distance between A and B is ℓ . The total time for the round trip is:
 - $\frac{2\ell}{\sqrt{V^2 - v^2}}$
 - $\frac{2v\ell}{V^2 - v^2}$
 - $\frac{2V\ell}{V^2 - v^2}$
 - $\frac{2\ell}{\sqrt{V^2 + v^2}}$
- Man A is sitting in a car moving with a speed of 54 km/hr observes a man B in front of the car crossing perpendicularly a road of width 15 m in three seconds. Then the velocity of man B (in m/s) will be:
 - $5\sqrt{10}$ towards the car at some angle
 - $5\sqrt{10}$ away from the car at some angle
 - 5 perpendicular to the road
 - 15 along the road
- A train is standing on a platform, a man inside a compartment of a train drops a stone. At the same instant train starts to move with constant acceleration. The path of the particle as seen by the person who drops the stone is:
 - parabola
 - straight line for some time & parabola for the remaining time
 - straight line
 - variable path that cannot be defined
- A man wearing a hat of extended length 12 cm is running in rain falling vertically downwards with speed 10 m/s. The maximum speed with which man can run, so that rain drops do not fall on his face (the length of his face below the extended part of the hat is 16 cm) will be
 - 7.5 m/s
 - 13.33 m/s
 - 10 m/s
 - zero
- Two men P & Q are standing at corners A & B of square ABCD of side 8 m. They start moving along the track with constant speed 2 m/s and 10 m/s respectively. Find the time when they will meet for the first time
 - 2 sec
 - 3 sec
 - 1 sec
 - 6 sec
- A swimmer crosses a river with minimum possible time 10 second. And when he reaches the other end starts swimming in the direction towards the point from where he started swimming. Keeping the direction fixed the swimmer crosses the river in 15 sec. The ratio of speed of swimmer with respect to water and the speed of river flow is (Assume constant speed of river & swimmer)
 - $\frac{3}{2}$
 - $\frac{9}{4}$
 - $\frac{2}{\sqrt{5}}$
 - $\frac{\sqrt{5}}{2}$
- A cat runs along a straight line with constant velocity of magnitude v . A dog chases the cat such that the velocity of dog is always directed towards the cat. The speed of dog is 'u' and always constant. At the instant both are separated by distance x and their velocities are mutually perpendicular, the magnitude of acceleration of dog is.
 - $\frac{uv}{x}$
 - $\frac{u^2}{x}$
 - $\frac{v^2}{x}$
 - $\frac{u^2 + v^2}{x}$
- Person A observes B moving in east direction with speed 10 m/s, B observes C moving in south direction with speed 20 m/s, C observes D moving in west direction with speed 30 m/s & D observes a tree moving with speed 40 m/s in north direction. Then the actual direction of motion of person 'A' will be
 - north-west
 - north-east
 - south-east
 - none of these
- Two motor boats A and B move from same point along a circle of radius 10 m in still water. The boats are so designed that they can move only with constant speeds. The



boats A and B take 16 and 8 sec respectively to complete one circle in stationary water. Now water starts flowing at $t = 0$ with a speed 4 m/s in a fixed direction. Find the distance between the boats after $t = 8$ sec.

- (a) 10 m (b) 20 m
(c) 100 m (d) none of these

10. A man starts running along a straight road with uniform velocity observes that the rain is falling vertically downward. If he doubles his speed, he finds that the rain is coming at an angle θ to the vertical. The velocity of rain with respect to the ground is:

- (a) $u\hat{i} - u \tan \theta \hat{j}$ (b) $u\hat{i} - u \cot \theta \hat{j}$
(c) $u\hat{i} + u \cot \theta \hat{j}$ (d) $\frac{u}{\tan \theta} \hat{i} - u\hat{j}$

11. For four particles A, B, C & D, the velocities of one with respect to other are given as $\vec{V}_{DC}$ is 20 m/s towards north, $\vec{V}_{BC}$ is 20 m/s towards east and $\vec{V}_{BA}$ is 20 m/s towards south. Then $\vec{V}_{DA}$ is
(a) 20 m/s towards north
(b) 20 m/s towards south
(c) 20 m/s towards east
(d) 20 m/s towards west

Multiple Correct Answers Type

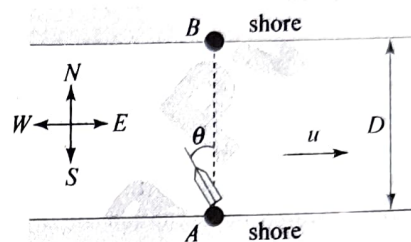
12. Two boats A and B having same speed relative to river are moving in a river. Boat A moves normal to the river current as observed by an observer moving with velocity of river current. Boat B moves normal to the river as observed by the observer on the ground.
(a) To a ground observer boat B moves faster than A
(b) To a ground observer boat A moves faster than B
(c) To the given moving observer boat B moves faster than A

- (d) To the given moving observer the speeds of boat A and B are same

Comprehension Type

For problem 13–15

Two ports, A and B, on a North-South line are separated by a river of width D . The river flows east with speed u . A boat crosses the river starting from port A. The speed of the boat relative to the river is v . Assume $v = 2u$.



13. What is the direction of the velocity of boat relative to river, θ , so that it crosses directly on a line from A to B?
(a) 30° west of north
(b) 30° east of north
(c) 60° west of north
(d) 60° east of north
14. Suppose the boat wants to cross the river from A to the other side in the shortest possible time. Then what should be the direction of the velocity of boat relative to river?
(a) 30° west of north
(b) 30° east of north
(c) 60° west of north
(d) along north
15. The boat crosses the river from A to the other side in shortest possible time, then how far is the boat from the port B after crossing the river
(a) $D/\sqrt{2}$ (b) $\sqrt{2}D$
(c) $2D$ (d) $D/2$

Answers Key

Single Correct Answer Type

1. (a) 2. (b) 3. (c) 4. (a) 5. (b)
6. (c) 7. (a) 8. (c) 9. (b) 10. (c)
11. (d)

Multiple Correct Answers Type

12. (b, d)

Comprehension Type

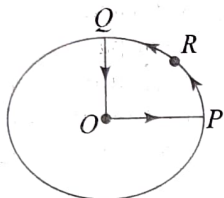
13. (b) 14. (b) 15. (d)

DPP 5.6

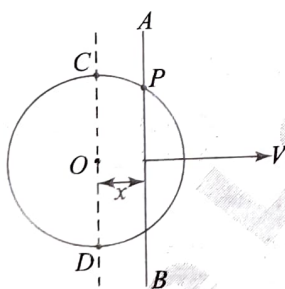
Kinematics of Circular Motion

Subjective Type

1. A cyclist starts from centre O of a circular park of radius 1 km and moves along the path $OPRQO$ as shown in figure. If he maintains constant speed of 10 ms^{-1} , what is his acceleration at point R in magnitude and direction?



2. A rod AB is moving on a fixed circle of radius R with constant velocity ' v ' as shown in figure. P is the point of intersection of the rod and the circle. At an instant the rod is at a distance $x = \frac{3R}{5}$ from centre of the circle. The velocity of the rod is perpendicular to the rod and the rod is always parallel to the diameter CD .



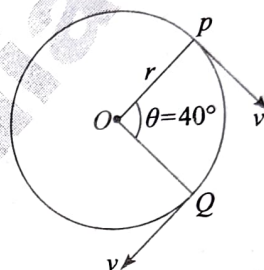
- (a) Find the speed of point of intersection P .
(b) Find the angular speed of point of intersection P with respect to centre of the circle.

Single Correct Answer Type

3. In uniform circular motion
(a) Both velocity and acceleration are constant
(b) Acceleration and speed are constant but velocity changes
(c) Both acceleration and velocity changes
(d) Both acceleration and speed are constant
4. A particle is revolving in a circle increasing its speed uniformly. Which of the following is constant?

- (a) centripetal acceleration (b) tangential acceleration
(c) angular acceleration (d) none of these

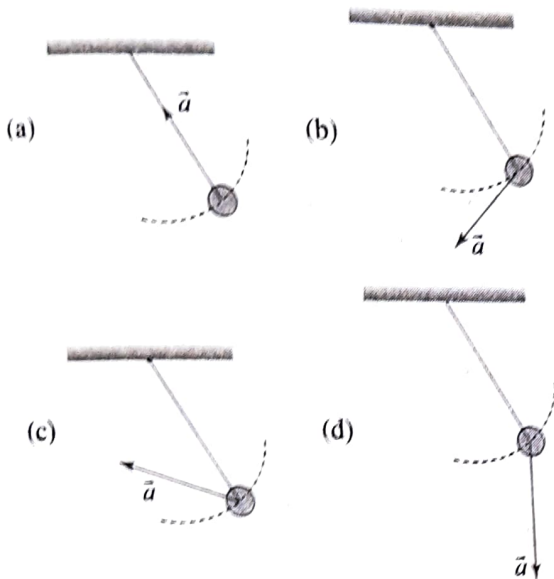
5. A particle is moving on a circular path of radius r with uniform velocity v . The change in velocity when the particle moves from P to Q is ($\angle POQ = 40^\circ$)



- (a) $2v \cos 40^\circ$ (b) $2v \sin 40^\circ$
(c) $2v \sin 20^\circ$ (d) $2v \cos 20^\circ$
6. A particle P is moving in a circle of radius ' a ' with a uniform speed v . C is the centre of the circle and AB is a diameter. When passing through B the angular velocity of P about A and C are in the ratio
(a) 1 : 1 (b) 1 : 2
(c) 2 : 1 (d) 4 : 1
7. The ratio of angular speeds of minute hand and hour hand of a watch is
(a) 1 : 12 (b) 6 : 1
(c) 12 : 1 (d) 1 : 6
8. What is the value of linear velocity, if $\vec{\omega} = 3\hat{i} - 4\hat{j} + \hat{k}$ and $\vec{r} = 5\hat{i} - 6\hat{j} + 6\hat{k}$?
(a) $6\hat{i} + 2\hat{j} - 3\hat{k}$ (b) $-18\hat{i} - 13\hat{j} + 2\hat{k}$
(c) $4\hat{i} - 13\hat{j} + 6\hat{k}$ (d) $6\hat{i} - 2\hat{j} + 8\hat{k}$
9. When a ceiling fan is switched off its angular velocity reduces to 50% while it makes 36 rotations. How many more rotation will it make before coming to rest (Assume uniform angular retardation)?
(a) 18 (b) 12 (c) 36 (d) 48
10. A car is moving with speed 30 m/sec on a circular path of radius 500 m. Its speed is increasing at the rate of 2 m/sec^2 . What is the acceleration of the car?
(a) 2 m/sec^2 (b) 2.7 m/sec^2
(c) 1.8 m/sec^2 (d) 9.8 m/sec^2
11. A car is travelling with linear velocity v on a circular road of radius r . If it is increasing its speed at the rate of ' a ' meter/ sec^2 , then the resultant acceleration will be

(a) $\sqrt{\left\{\frac{v^2}{r^2} - a^2\right\}}$ (b) $\sqrt{\left\{\frac{v^4}{r^2} + a^2\right\}}$
 (c) $\sqrt{\left\{\frac{v^4}{r^2} - a^2\right\}}$ (d) $\sqrt{\left\{\frac{v^2}{r^2} + a^2\right\}}$

12. A simple pendulum is oscillating without damping. When the displacement of the bob is less than maximum, its acceleration vector $\vec{a}$ is correctly shown in



13. A stone is projected from level ground at $t = 0$ sec such that its horizontal and vertical components of initial velocity are 10 m/s and 20 m/s respectively. Then the instant of time at which tangential and normal components of acceleration of stone are same is: (neglect air resistance) $g = 10 \text{ m/s}^2$.

- (a) $\frac{1}{2}$ sec (b) $\frac{3}{2}$ sec
 (c) 3 sec (d) 4 sec.

Multiple Correct Answers Type

14. A particle is acted upon by a force of constant magnitude which is always perpendicular to the velocity of the particle. The motion of the particle takes place in a plane. It follows that

- (a) Velocity is constant
 (b) Acceleration is constant
 (c) Kinetic energy is constant
 (d) It moves in a circular path

15. For a particle performing uniform circular motion, choose the correct statement(s) from the following.

- (a) Magnitude of particle velocity (speed) remains constant
 (b) Particle velocity remains directed perpendicular to radius vector
 (c) Direction of acceleration keeps changing as particle moves
 (d) Tangential acceleration of the particle is non zero.

Answers Key

Subjective Type

1. 0.1 m/s^2 along RO
 2. (a) $\frac{5}{4}V$ (b) $\frac{5V}{4R}$

Single Correct Answer Type

3. (c) 4. (c) 5. (c) 6. (b) 7. (c)
 8. (b) 9. (b) 10. (b) 11. (b) 12. (c)
 13. (c)

Multiple Correct Answers Type

14. (c, d) 15. (a, b, c)

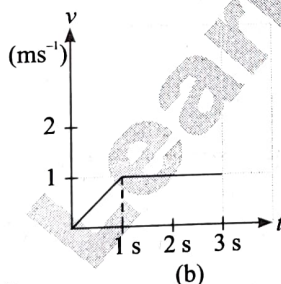
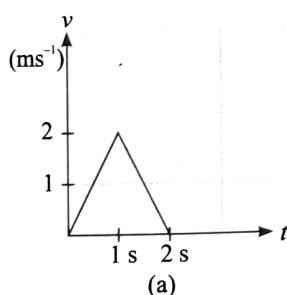
Newton's Laws of Motion I

DPP 6.1

Newton's Laws of Motion and Impulse

Subjective Type

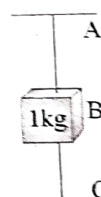
1. Figure shows (v_x, t) , and (v_y, t) diagrams for a body of unit mass. Find the force as a function of time.



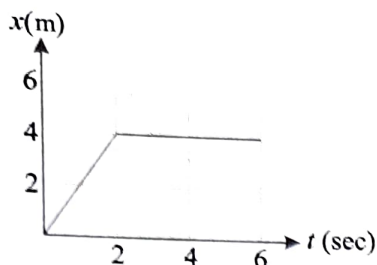
Single Correct Answer Type

2. A boy sitting on the topmost berth in the compartment of a train which is just going to stop on a railway station, drops an apple aiming at the open hand of his brother sitting vertically below his hands at a distance of about 2 meter. The apple will fall
- Precisely on the hand of his brother
 - Slightly away from the hand of his brother in the direction of motion of the train
 - Slightly away from the hand of his brother in the direction opposite to the direction of motion of the train
 - None of the above

3. A person sitting in an open car moving at constant velocity throws a ball vertically up into air. The ball falls
- Outside the car
 - In the car ahead of the person
 - In the car to the side of the person
 - Exactly in the hand which threw it up
4. A mass of 1 kg is suspended by a string A. Another string C is connected to its lower end (see figure). If the string C is stretched slowly, then
- The portion AB of the string will break
 - The portion BC of the string will break
 - None of the strings will break
 - None of the above



5. A machine gun is mounted on a 2000 kg car on a horizontal frictionless surface. At some instant the gun fires bullets of mass 10 gm with a velocity of 500 m/sec with respect to the car. The number of bullets fired per second is ten. The average thrust on the system is
- 550 N
 - 50 N
 - 250 N
 - 250 dyne
6. A machine gun fires a bullet of mass 40 g with a velocity 12 ms^{-1} . The man holding it can exert a maximum force of 144 N on the gun. How many bullets can he fire per second at the most?
- One
 - Four
 - Two
 - Three
7. In the figure given below, the position-time graph of a particle of mass 0.1 kg is shown. The impulse at $t = 2 \text{ sec}$ is



- (a) $0.2 \text{ kg m sec}^{-1}$ (b) $-0.2 \text{ kg m sec}^{-1}$
 (c) $0.1 \text{ kg m sec}^{-1}$ (d) $-0.4 \text{ kg m sec}^{-1}$
8. A body of mass 2 kg has an initial velocity of 3 m/s along OE and it is subjected to a force of 4 N in a direction perpendicular to OE . The distance of the body from O after 4 s will be
 (a) 12 m (b) 20 m (c) 8 m (d) 48 m
9. A particle moves in the xy -plane under the action of a force $\vec{F}$ such that the components of its linear momentum $\vec{p}$ at any time t are $p_x = 2 \cos t$, $p_y = 2 \sin t$. The angle between $\vec{F}$ and $\vec{p}$ at time t is
 (a) 90° (b) 0° (c) 180° (d) 30°

Multiple Correct Answers Type

10. The motion of a particle of mass m is given by $x = 0$ for $t < 0 \text{ s}$, $x(t) = A \sin 4\pi t$ for $0 < t < (1/4) \text{ s}$ ($A > 0$), and $x = 0$ for $t > (1/4) \text{ s}$. Which of the following statements are true?
 (a) The force at $t = (1/8) \text{ s}$ on the particle is $-16 \pi^2 A \text{ m}$
 (b) The particle is acted upon by an impulse of magnitude $4\pi^2 A \text{ m}$ at $t = 0 \text{ s}$ and $t = (1/4) \text{ s}$
 (c) The particle is not acted upon by any force
 (d) The particle is not acted upon by a constant force

11. Two billiard balls A and B , each of mass 50 g and moving in opposite directions with speed of 5 m/s each, collide and rebound with the same speed. If the collision lasts for 10^{-3} s , which of the following statements are true?
 (a) The impulse imparted to each ball is 0.25 kg-m/s and the force on each ball is 250 N
 (b) The impulse imparted to each ball is 0.25 kg-m/s and the force exerted on each ball is $25 \times 10^{-5} \text{ N}$
 (c) The impulse imparted to each ball is 0.5 N-s
 (d) The impulse and the force on each ball are equal in magnitude and opposite in directions

Matching Column Type

12. If the net force acting on a system is represented by $\vec{F}$ and its momentum is $\vec{P}$, then match the entries of column-I with the entries of column-II.

	Column-I		Column-II
(p)	if $\vec{F}$ is constant	(a)	$\vec{p}$ may change its direction
(q)	if $\vec{F}$ is changing in magnitude only	(b)	$\vec{p}$ must change its magnitude
(r)	if $\vec{F}$ is changing in direction only	(c)	$\vec{p}$ may not change its direction
(s)	if $\vec{F}$ is zero	(d)	$\vec{p}$ must not change its direction

Answers Key

Subjective Type

1. $\vec{F} = (2\hat{i} + \hat{j}) \text{ N}$ for $0 < t < 1 \text{ s}$
 $= -2\hat{i} \text{ N}$ for $1 \text{ s} < t < 2 \text{ s}$
 $= 0$ for $t > 2 \text{ s}$

Single Correct Answer Type

2. (b) 3. (d) 4. (a) 5. (b) 6. (d)

7. (b) 8. (b) 9. (a)

Multiple Correct Answers Type

10. (a, b, d) 11. (c, d)

Matching Column Type

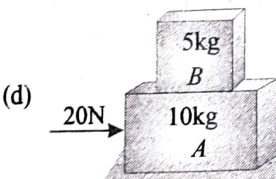
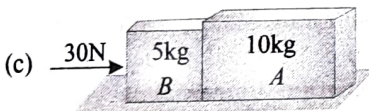
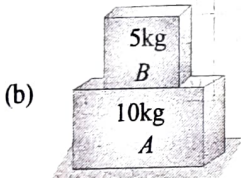
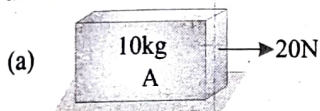
12. (p $\rightarrow$ a, b, c), (q $\rightarrow$ a, b, c), (r $\rightarrow$ a), (s $\rightarrow$ d)

DPP 6.2

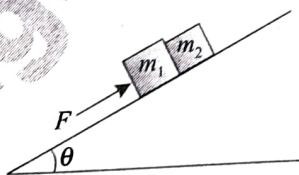
Concept of Free Body Diagram

Subjective Type

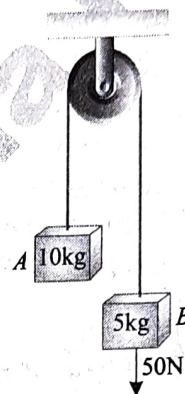
- A helicopter of mass 2000 kg rises with a vertical acceleration of 15 ms^{-2} . The total mass of the crew and passengers is 500 kg. Give the magnitude and direction of the ($g = 10 \text{ ms}^{-2}$)
 - force on the floor of the helicopter by the crew and passengers.
 - action of the rotor of the helicopter on the surrounding air.
 - force on the helicopter due to the surrounding air.
- Find all the normal reactions N_{AG} , N_{BG} , N_{AB} and the accelerations of A and B (All surfaces are friction less):



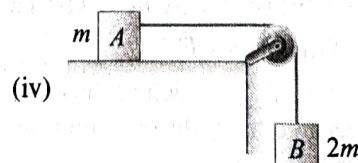
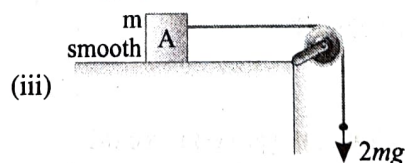
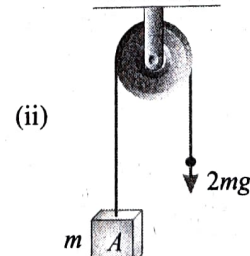
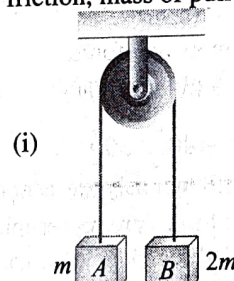
- Two blocks are placed at rest on a smooth fixed inclined plane. A force F acts on block of mass m_1 and is parallel to the inclined plane as shown in figure. Both blocks move up the incline. Then



- Find normal reaction between the blocks of mass m_1 and m_2
- Find out the accelerations of the blocks and tensions in the strings.

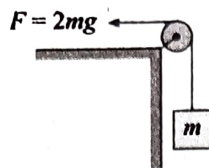


- In which of the following cases the magnitude of acceleration of the block A will be maximum (Neglecting friction, mass of pulley and string)



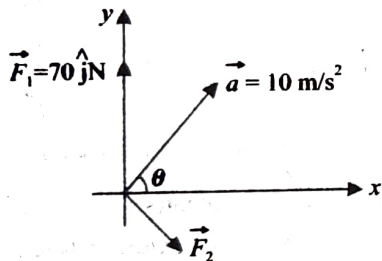
- Draw free body diagram of block of mass m_1 and block mass m_2
- Find accelerations of block of mass m_1 and block mass m_2

6. The block of mass ' m ' is being pulled by a horizontal force $F = 2mg$ applied to a string as shown in figure (Take $g = 10 \text{ m/s}^2$). The pulley is massless and is fixed at the edge of an immovable table. What is the value of force exerted by the supporting table on the pulley (in Newton)

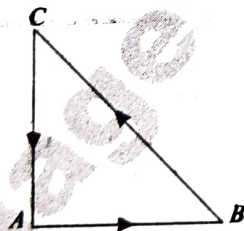


Single Correct Answer Type

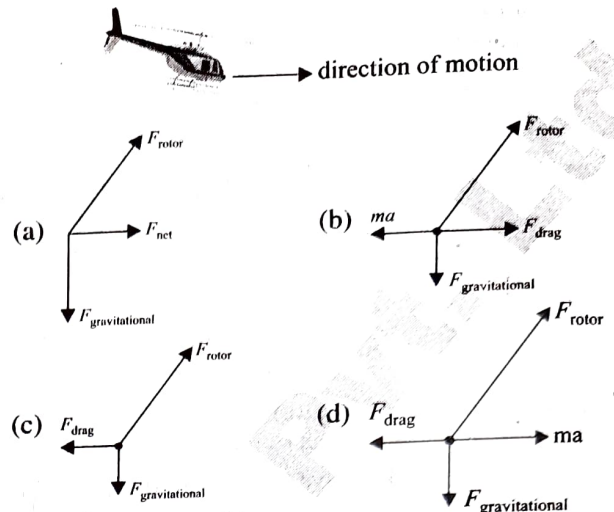
7. A particle of mass $m = 5 \text{ kg}$, is momentarily at rest at $x = 0$ at $t = 0$. It is acted upon by two forces $\vec{F}_1$ and $\vec{F}_2$. It is given that $\vec{F}_1 = 70 \text{ N } \hat{j}$ and $\vec{F}_2$ is unknown. The particle experiences a constant acceleration $\vec{a}$, in the direction as shown. What third force, $\vec{F}_3$, is required to make the acceleration of the particle zero? (Note: $\sin \theta = 4/5$, $\cos \theta = 3/5$, and $\tan \theta = 4/3$. Neglect gravity.)



- (a) $30\hat{i} + 40\hat{j}$ (b) $-(30\hat{i} + 40\hat{j})$
 (c) $40\hat{i} + 30\hat{j}$ (d) $-(40\hat{i} + 30\hat{j})$
8. Three forces starts acting simultaneously on a particle moving with velocity $\vec{v}$. These forces are represented in magnitude and direction by the three sides of a triangle ABC (as shown). The particle will now move with velocity



- (a) $\vec{v}$ remains unchanged
 (b) Less than $\vec{v}$
 (c) Greater than $\vec{v}$
 (d) $\vec{v}$ in the direction of the largest force BC
9. A helicopter is moving to the right at a constant horizontal velocity. It experiences three forces $\vec{F}_{\text{gravitational}}$, $\vec{F}_{\text{drag}}$ and force on it caused by rotor $\vec{F}_{\text{rotor}}$. Which of the following diagrams can be correct free body diagram representing forces on the helicopter?



10. As shown to the right, two blocks with masses m and M ($M > m$) are pushed by a force F in both Case I and Case II. The surface on which blocks lie, is horizontal and frictionless. Let R_I be the force that m exerts on M in case I and R_{II} be the force that m exerts on M in case II. Which of the following statements is true?



- (a) $R_I = R_{II}$ and is not equal to zero or F
 (b) $R_I = R_{II} = F$
 (c) $R_I < R_{II}$
 (d) $R_I > R_{II}$
11. Consider the three cases given in figures shown. Assume the friction to be absent everywhere and the pulleys to be light; the string connecting the blocks to other block or fixed vertical wall to be light and inextensible. Let T_A , T_B and T_C be the tension in the strings in figure A, figure B and figure C respectively. Then pick the correct comparison between the given tensions (for the instant shown) from options below.

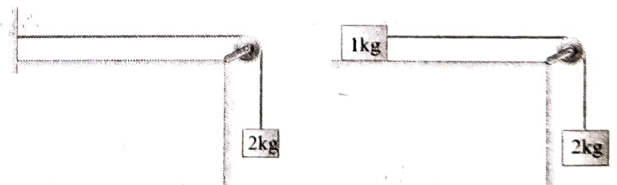


Fig. (A)

Fig. (B)

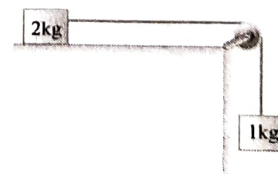
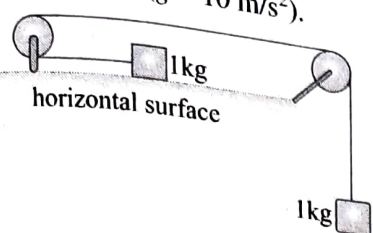


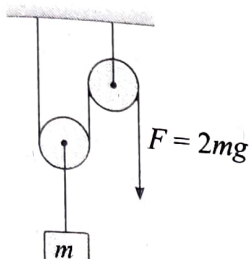
Fig. (C)

- (a) $T_A = T_B = T_C$ (b) $T_B = T_C < T_A$
 (c) $T_A < T_B < T_C$ (d) $T_B < T_C < T_A$

12. Consider the system as shown in the figure. The pulley and the string are light and all the surfaces are frictionless. The tension in the string is ($g = 10 \text{ m/s}^2$).



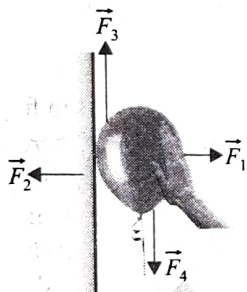
- (a) 0 N (b) 1 N (c) 2 N (d) 5 N
13. In the shown mass pulley system, pulleys and string are massless. The one end of the string is pulled by the force $F = 2mg$. The acceleration of the block will be



- (a) $g/2$ (b) 0 (c) g (d) $3g$

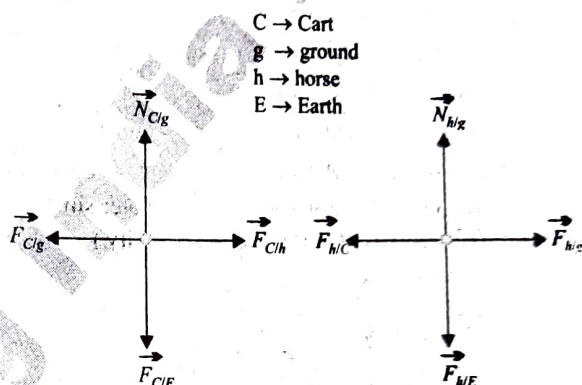
Multiple Correct Answers Type

14. In the figure shown, a balloon is pressed against a wall. It is in equilibrium and maximum compressed state.



$\vec{F}_1$ = force of balloon on hand of man; $\vec{F}_2$ = force of balloon on wall; $\vec{F}_3$ = friction; $\vec{F}_4$ = weight of balloon. Which of the following statements are correct:

- (a) $\vec{F}_1$ and $\vec{F}_2$ are action reaction pairs
 (b) $\vec{F}_3$ and $\vec{F}_4$ are action reaction pairs
 (c) $\vec{F}_1 + \vec{F}_2 = 0$
 (d) $\vec{F}_3 + \vec{F}_4 = 0$
15. Consider a cart being pulled by a horse with constant velocity. The horse exerts force $\vec{F}_{Ch}$ on the cart. (The subscript indicate the force on the cart due to horse.). The first subscript denotes the body on which force acts and second due to which it acts.



Free body diagram of cart

Free body diagram of horse

Choose the correct statement(s):

- (a) $\vec{F}_{C/g}$, $\vec{N}_{C/g}$, $\vec{N}_{h/g}$ are external forces on a system consisting of horse and cart.
 (b) $\vec{F}_{h/g} + \vec{F}_{C/g} = 0$
 (c) $\vec{N}_{C/g}$ and $\vec{F}_{C/E}$ are action reaction pairs.
 (d) $\vec{F}_{C/h}$ and $\vec{F}_{h/C}$ are action reaction pairs

Answers Key

Subjective Type

1. (a) 12500 N (downward) (b) 62500 N (downward)
 (c) 62500 N (upward)
 4. zero, 100 N
 5. (iii)
 6. $2\sqrt{2}mg$

Single Correct Answer Type

7. (b) 8. (a) 9. (c) 10. (c) 11. (d)
 12. (d) 13. (d)

Multiple Correct Answers Type

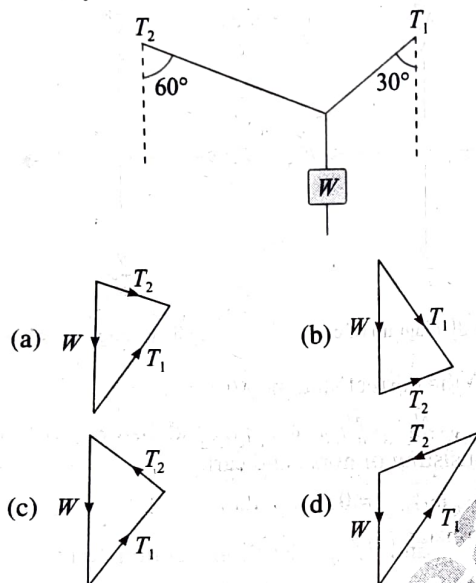
14. (c, d) 15. (a, b, d)

DPP 6.3

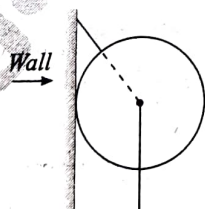
Equilibrium of Forces

Single Correct Answer Type

1. A weight W is supported by two strings inclined at 60° and 30° to the vertical. The tensions in the strings are T_1 and T_2 as shown. If these tensions are to be determined in terms of W using a triangle of forces, which of these triangles should you draw? (block is in equilibrium)

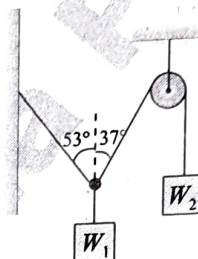


2. Which of the following sets of concurrent forces may be in equilibrium?
- $F_1 = 3 \text{ N}, F_2 = 5 \text{ N}, F_3 = 9 \text{ N}$
 - $F_1 = 3 \text{ N}, F_2 = 5 \text{ N}, F_3 = 1 \text{ N}$
 - $F_1 = 3 \text{ N}, F_2 = 5 \text{ N}, F_3 = 15 \text{ N}$
 - $F_1 = 3 \text{ N}, F_2 = 5 \text{ N}, F_3 = 6 \text{ N}$
3. A uniform sphere of weight w and radius 3 m is being held by a string of length 2 m , attached to a frictionless wall as shown in the figure. The tension in the string will be:



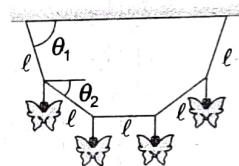
- $5w/4$
- $15w/4$
- $15w/16$
- none of these

4. Two weights W_1 and W_2 in equilibrium and at rest are suspended as shown in figure. Then the ratio $\frac{W_1}{W_2}$ is:

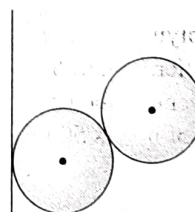


- $5/4$
- $4/5$
- $8/5$
- none of these

5. Four identical metal butterflies are hanging from a light string of length $5l$ at equally placed points as shown. The ends of the string are attached to a horizontal fixed support. The middle section of the string is horizontal. The relation between the angle θ_1 and θ_2 is given by

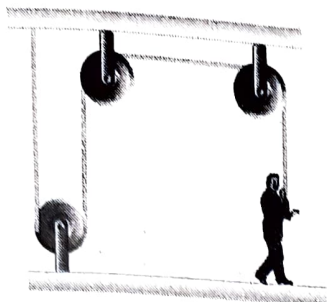


- $\sin \theta_1 = 2 \sin \theta_2$
 - $2 \cos \theta_1 = \sin \theta_2$
 - $\tan \theta_1 = 2 \tan \theta_2$
 - $\theta_2 < \theta_1$ and no other conclusion can be derived.
6. Two smooth spheres each of radius 5 cm and weight W rest one on the other inside a fixed smooth cylinder of radius 8 cm . The reactions between the spheres and the vertical side of the cylinder are:

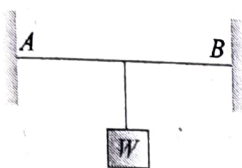


- $W/4$ and $3W/4$
 - $W/4$ and $W/4$
 - $3W/4$ and $3W/4$
 - W and W
7. A 50 kg person stands on a 25 kg platform. He pulls on the rope which is attached to the platform via the frictionless pulleys as shown in the figure. The platform moves upward

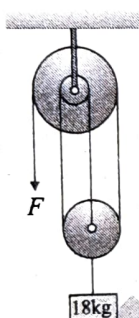
at a steady rate if the force with which the person pulls the rope is:



- (a) 500 N (b) 250 N
(c) 25 N (d) 50 N
8. Find the tension in the string AB loaded with weight W at the middle, when AB is horizontal:



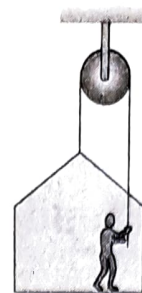
- (a) zero (b) W
(c) $W/2$ (d) infinity
9. In the figure, at the free end of the light string, a force F is applied to keep the suspended mass of 18 kg at rest. Then the force exerted by the ceiling on the system (assume that the string segments are vertical and the pulleys are light and smooth) is: ($g = 10 \text{ m/s}^2$)



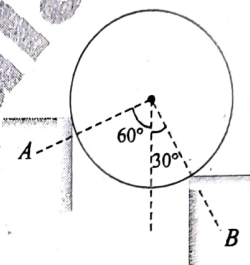
- (a) 60 N (b) 120 N
(c) 180 N (d) 240 N

Multiple Correct Answers Type

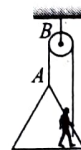
10. A painter is applying force himself to raise him and the box with an acceleration of 5 m/s^2 by a massless rope and pulley arrangement as shown in figure. Mass of painter is 100 kg and that of box is 50 kg. If $g = 10 \text{ m/s}^2$, then:



- (a) tension in the rope is 1125 N
(b) tension in the rope is 2250 N
(c) force of contact between the painter and the floor is 375 N
(d) none of these
11. A cylinder of mass M and radius R is resting on two corner edges A and B as shown in figure. The normal reaction at the edges A and B are: (Neglect friction)



- (a) $N_A = \sqrt{2}N_B$ (b) $N_B = \sqrt{3}N_A$
(c) $N_A = \frac{Mg}{2}$ (d) $N_B = \frac{2\sqrt{3}Mg}{5}$
12. To paint the side of a building, painter normally hoists himself up by pulling on the rope A as in figure. The painter and platform together weigh 200 N. The rope B can withstand 300 N. Then



- (a) The maximum acceleration that painter can have upwards is 5 m/s^2 .
(b) To hoist himself up, rope B must withstand minimum 400 N force.
(c) Rope A will have a tension of 100 N when the painter is at rest.
(d) The painter must exert a force of 200 N on the rope A to go downwards slowly.

Answers Key

Single Correct Answer Type

1. (c) 2. (d) 3. (a) 4. (a) 5. (c)
6. (c) 7. (b) 8. (d) 9. (d)

Multiple Correct Answers Type

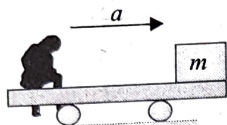
10. (a, c) 11. (b, c) 12. (a, c)

DPP 6.4

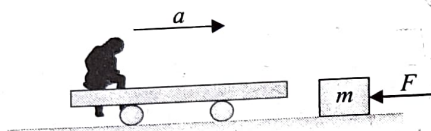
Concept of Pseudo Force

Subjective Type

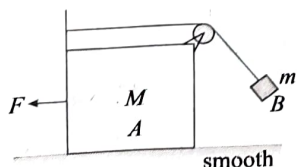
1. Suppose you are sitting on an accelerating trolley car.



- (i) Find the pseudo force acting on the block of mass m placed on the trolley car.
If the block is placed (or moved) outside the trolley car, and an external force F acts in horizontal direction



- (ii) find the pseudo force acting on the block as viewed by the observer.
(iii) Find the acceleration of the block as seen by the observer.
2. A man of mass m is standing on a lift which moves down with an upward acceleration a . Find the pseudo force acting on the man as observed by himself. Find the pseudo force acting on the man if the lift falls freely.
3. The block of mass m is in equilibrium relative to the smooth wedge of mass M which is pushed by a horizontal force F . Find pseudo force acting on (i) m , (ii) M as viewed by the observer sitting on the wedge. Will these pseudo forces be (i) equal and opposite, action-reaction pairs? Explain.
4. A force F is applied on block A of mass M so that the tension in light string also becomes F when block B of mass m acquires an equilibrium state with respect to block A . Find the force F . Give your answer in terms of m , M and g .

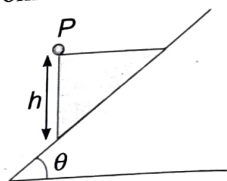


Single Correct Answer Type

5. A car is moving on a plane inclined at 30° to the horizontal with an acceleration of 10 m/s^2 parallel to the plane upward. A bob is suspended by a string from the roof. The angle in degrees which the string makes with the vertical is: (Assume that the bob does not move relative to car) [$g = 10 \text{ m/s}^2$]

(a) 20° (b) 30° (c) 45° (d) 60°

6. A wedge of height ' h ' is released from rest with a light particle P placed on it as shown. The wedge slides down an incline which makes an angle θ with the horizontal. All the surfaces are smooth, P will reach the surface of the incline in time:



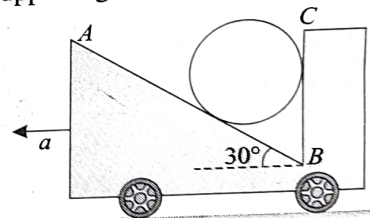
(a) $\sqrt{\frac{2h}{g \sin^2 \theta}}$

(b) $\sqrt{\frac{2h}{g \sin \theta \cos \theta}}$

(c) $\sqrt{\frac{2h}{g \tan \theta}}$

(d) $\sqrt{\frac{2h}{g \cos^2 \theta}}$

7. A cylinder rests in a supporting carriage as shown. The side AB of carriage makes an angle 30° with the horizontal and side BC is vertical. The carriage lies on a fixed horizontal surface and is being pulled towards left with an horizontal acceleration ' a '. The magnitude of normal reactions exerted by sides AB and BC of carriage on the cylinder be N_{AB} and N_{BC} respectively (Neglect friction everywhere). Then as the magnitude of acceleration ' a ' of the carriage is increased, pick up the correct statement:



(a) N_{AB} increases and N_{BC} decreases.

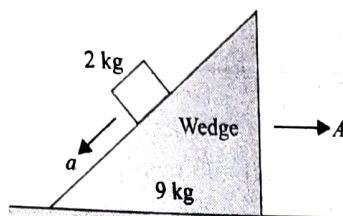
(b) Both N_{AB} and N_{BC} increase.

(c) N_{AB} remains constant and N_{BC} increases.

(d) N_{AB} increases and N_{BC} remains constant.

8. A ball is suspended on a thread from the ceiling of a car. The brakes are applied and the speed of car changes from 5 m/sec to $5/3 \text{ m/sec}$ during the time interval of 3 seconds. Find the angle that the thread with the ball will deviate from vertical.

- (a) $\theta = \tan^{-1}\left(\frac{1}{9}\right)$ (b) $\theta = \tan^{-1}\left(\frac{8}{9}\right)$
 (c) $\theta = \cos^{-1}\left(\frac{1}{9}\right)$ (d) $\theta = \sin^{-1}\left(\frac{1}{9}\right)$
9. A block of mass 2 kg slides down the face of a smooth 45° wedge of mass 9 kg as shown in figure. The wedge is placed on a frictionless horizontal surface. Determine the acceleration of the wedge.

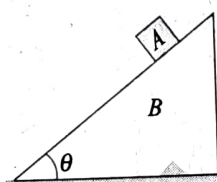


- (a) 2 m/s^2 (b) $\frac{11}{\sqrt{2}} \text{ m/s}^2$
 (c) 1 m/s^2 (d) none of these
10. A body of mass m is placed over a smooth inclined plane of inclination θ , which is placed over a lift which is moving up with an acceleration a_0 . Base length of the inclined plane is L . Calculate the velocity of the block with respect to lift at the bottom, if it is allowed to slide down from the top of the plane from rest.

- (a) $\sqrt{2(a_0 + g)L \sin \theta}$ (b) $\sqrt{2(a_0 + g)L \cos \theta}$
 (c) $\sqrt{2(a_0 + g)L \tan \theta}$ (d) $\sqrt{2(a_0 + g)L \cot \theta}$

Multiple Correct Answers Type

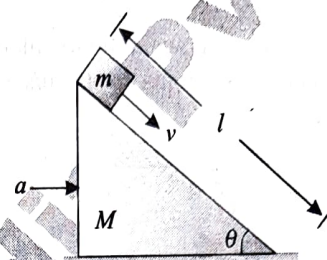
11. In the figure shown, A and B are free to move. All the surfaces are smooth. ($0 < \theta < 90^\circ$)



- (a) the acceleration of A will be more than $g \sin \theta$
 (b) the acceleration of A will be less than $g \sin \theta$
 (c) normal force on A due to B will be more than $mg \cos \theta$
 (d) normal force on A due to B will be less than $mg \cos \theta$

Comprehension Type

A smooth wedge of mass M is pushed with an acceleration $a = g \tan \theta$ and a block of mass m is projected down the slant with a velocity v relative to the wedge.



12. The time taken by the block to reach the ground is:

- (a) $\frac{l}{v}$ (b) $\sqrt{\frac{2l}{g \sin \theta}}$
 (c) $\sqrt{\frac{2l}{g \cos \theta}}$ (d) $\frac{v}{g \sin \theta}$

13. The normal reaction between wedge and block is:

- (a) $mg \cos \theta$ (b) $mg \sec \theta$
 (c) $mg \cot \theta$ (d) $mg \tan \theta$

14. The horizontal force applied on the wedge is:

- (a) $(M + m)g \sin \theta$ (b) $(M + m)g \cos \theta$
 (c) $Mg \tan \theta$ (d) $(M + m)g \tan \theta$

15. The normal reaction offered by ground to the wedge is:

- (a) $(M + m)g$ (b) $(M + m)g \cos \theta$
 (c) $mg \sin^2 \theta + Mg$ (d) $(M + m)g + mg \cos^2 \theta$

Answers Key

Subjective Type

1. (i) $\vec{F}_{ps} = -ma\hat{i}$ (ii) $\vec{F}'_{ps} = -ma\hat{i}$
 (iii) $\vec{a}_{m, \text{observer}} = -\left(a + \frac{F}{m}\right)\hat{i}$
 2. ma (downward), mg (upward)
 3. (i) $\vec{F}_{ps} = -\frac{mF}{M+m}\hat{i}$ (ii) $\vec{F}'_{ps} = -\frac{MF}{F+m}\hat{i}$; No
 4. $\frac{mg}{\sqrt{1 - \left(\frac{m}{m+M}\right)^2}}$

Single Correct Answer Type

5. (b) 6. (a) 7. (c) 8. (a) 9. (c)
 10. (c)

Multiple Correct Answers Type

11. (a, d)

Comprehension Type

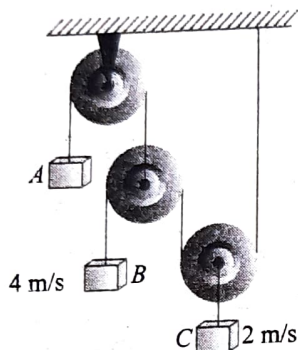
12. (a) 13. (b) 14. (d) 15. (a)

DPP 6.5

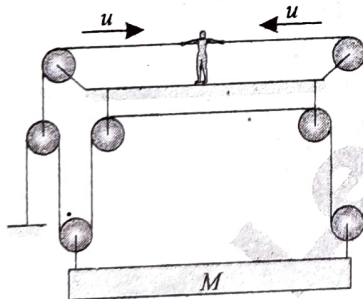
Constraint Relations

Subjective Type

1. In the pulley system shown in figure, block C is going up at 2 m/s and block B is going up at 4 m/s. Find the velocity of block A.

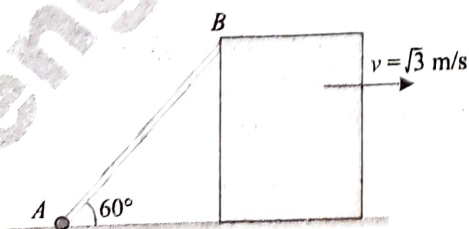


2. System is shown in the figure and man is pulling the rope from both sides with constant speed 'u'. Find the speed of the block.



Single Correct Answer Type

3. A rod AB is shown in figure. End A of the rod is fixed on the ground. Block is moving with velocity m/s towards right. The velocity of end B of rod when rod makes an angle of 60° with the ground is:



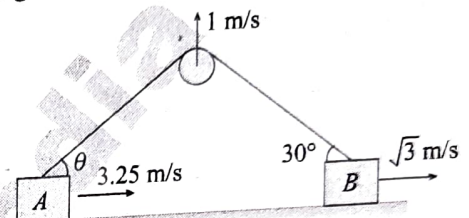
(a) $\sqrt{3}$ m/s

(b) 2 m/s

(c) $2\sqrt{3}$ m/s

(d) 3 m/s

4. In the figure shown, find out the value of θ [assume string to be tight]



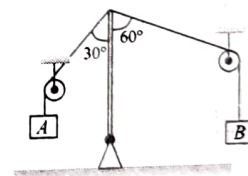
(a) $\tan^{-1} \frac{3}{4}$

(b) $\tan^{-1} \frac{4}{3}$

(c) $\tan^{-1} \frac{3}{8}$

(d) none of these

5. A rod can freely rotate in vertical plane about the hinge at its bottom. Two strings tie the top of the rod with blocks A and B as shown in the figure. At the instant shown, the rod is vertical and the speed of block A is u m/s downwards. Find the speed of block B.



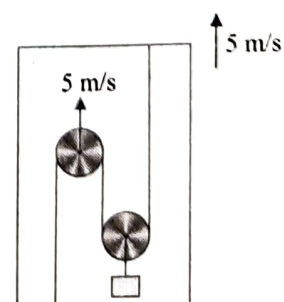
(a) $\sqrt{3}u$

(b) u

(c) $\frac{u}{2\sqrt{2}}$

(d) $\sqrt{\frac{2}{3}}u$

6. A lift is moving upwards with a constant speed of 5 m/s. The speed of one of the pulleys is 5 m/s as shown. Then the speed of second pulley is:



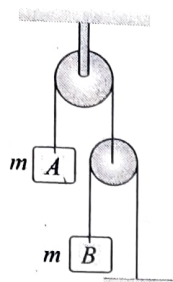
(a) 5 m/s

(b) zero

(c) 7.5 m/s

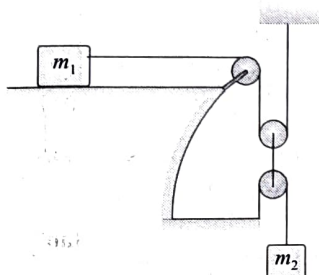
(d) 10 m/s

7. In the figure shown neglecting friction and mass of pulleys, what is the acceleration of mass B?



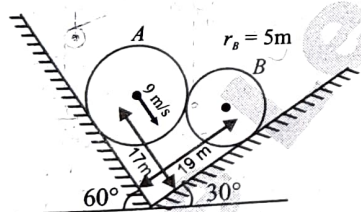
- (a) $\frac{g}{3}$ (b) $\frac{5g}{2}$ (c) $\frac{2g}{2}$ (d) $\frac{2g}{5}$

8. Two blocks of masses m_1 and m_2 are connected as shown in the figure. The acceleration of the block m_2 is:



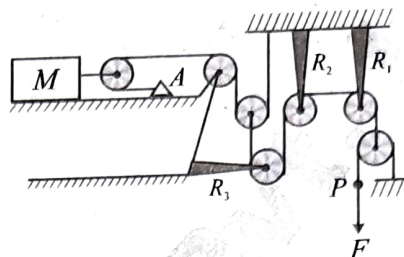
- (a) $\frac{m_2 g}{m_1 + m_2}$ (b) $\frac{m_1 g}{m_1 + m_2}$
(c) $\frac{4m_2 g - m_1 g}{m_1 + m_2}$ (d) $\frac{m_2 g}{m_1 + 4m_2}$

9. System is shown in the figure. Velocity of sphere A is 9 m/s. Find the speed of sphere B.



- (a) 9 m/s (b) 12 m/s
(c) $9 \times \frac{5}{4}$ m/s (d) none of these

10. In the given arrangement, mass of the block is M and the surface on which the block is placed is smooth. Assuming all pulleys to be massless and frictionless, strings to be inelastic and light, R_1 , R_2 and R_3 to be light supporting rods, then acceleration of point 'P' will be (A is fixed):



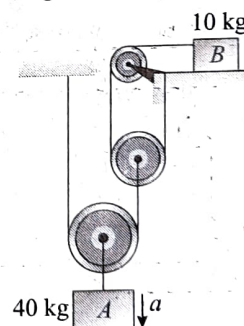
- (a) 0 (b) ∞
(c) $\frac{4F}{m}$ (d) $\frac{2F}{m}$

11. In the above question, find out the magnitude of net force exerted by the pulley on the rod R_1 :

- (a) 2F (b) F
(c) $2\sqrt{2}F$ (d) $\frac{F}{\sqrt{2}}$

Multiple Correct Answers Type

12. Figure shows two blocks A and B connected to an ideal pulley string system. In this system when bodies are released then: (neglect friction and take $g = 10 \text{ m/s}^2$)



- (a) Acceleration of block A is 1 m/s^2
(b) Acceleration of block A is 2 m/s^2
(c) Tension in string connected to block B is 40 N
(d) Tension in string connected to block B is 80 N

Answers Key

8. (a) 9. (b) 10. (c) 11. (c)

Multiple Correct Answers Type

12. (b, d)

Subjective Type

1. 4 m/s $\downarrow$ 2. $\frac{3u}{4}$

Single Correct Answer Type

3. (b) 4. (a) 5. (a) 6. (a) 7. (d)

DPP 6.6

Miscellaneous Applications

Single Correct Answer Type

1. A perfectly straight portion of a uniform rope has mass M and length L . At end A of the segment, the tension in the rope is T_A and at end B it is T_B ($T_B > T_A$). Neglect effect of gravity and no contact force acts on the rope in between points A and B. The tension in the rope at a distance $L/5$ from end A is

- (a) $T_B - T_A$ (b) $(T_A + T_B)/5$
(c) $(4T_A + T_B)/5$ (d) $(T_A - T_B)/5$

2. A uniform rope of length L and mass M is placed on a smooth fixed wedge as shown. Both ends of rope are at same horizontal level. The rope is initially released from rest, then the magnitude of initial acceleration of rope is

- (a) Zero (b) $M(\cos \alpha - \cos \beta)g$
(c) $M(\tan \alpha - \tan \beta)g$ (d) None of these

3. In the figure if block A and wedge B will move with same acceleration, then the magnitude of normal reaction between the block and the wedge will be (There is no friction between block and the wedge and the wedge moves on horizontal surface as shown.)

- (a) $2mg/\cos \theta$ (b) $2mg \cos \theta$
(c) $mg \cos \theta$ (d) none of these

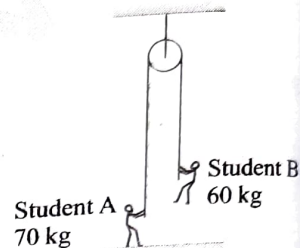
4. A block is placed on a smooth wedge of inclination angle θ with the horizontal. What minimum acceleration should be given to the wedge in the horizontal direction so that the block starts moving up along the incline?

- (a) $>g \cot \theta$ (b) $>g \tan \theta$
(c) $>g \sin \theta$ (d) $>g \cos \theta$

5. A rope of negligible mass passes over a pulley of negligible mass attached to the ceiling, as shown in figure. One end of the rope is held by Student A of mass 70 kg, who is at rest on the floor. The opposite end of the rope is held by

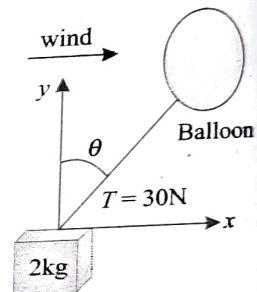
Student B of mass 60 kg, who is suspended at rest above the floor. The minimum acceleration a_0 with which the Student B should climb up the rope to lift the Student A upward off the floor.

- (a) $\frac{1}{3} \text{ m/s}^2$ (b) $\frac{2}{3} \text{ m/s}^2$
(c) $\frac{4}{3} \text{ m/s}^2$ (d) $\frac{5}{3} \text{ m/s}^2$



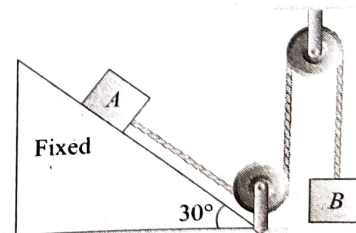
6. A balloon is tied to a block. The mass of the block is 2 kg. The tension of the string between the balloon and the block is 30 N. Due to the wind, the string has an angle θ relative to the vertical direction, $\cos \theta = 4/5$ and $\sin \theta = 3/5$. Assume the acceleration of gravity is $g = 10 \text{ m/s}^2$. Also assume the block is small so the force on the block from the wind can be ignored. Then the x-component and the y-component of the acceleration a of the block.

- (a) $9 \text{ m/s}^2, 2 \text{ m/s}^2$ (b) $9 \text{ m/s}^2, 12 \text{ m/s}^2$
(c) $18 \text{ m/s}^2, 2 \text{ m/s}^2$ (d) $18 \text{ m/s}^2, 12 \text{ m/s}^2$



Multiple Correct Answers Type

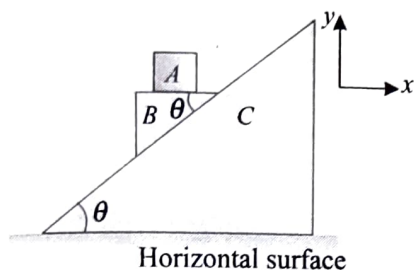
7. Two blocks A and B of equal mass m are connected through a massless string and arranged as shown in figure. The wedge is fixed on horizontal surface. Friction is absent everywhere. When the system is released from rest.



- (a) tension in string is $\frac{mg}{2}$

- (b) tension in string is $\frac{mg}{4}$
 (c) acceleration of A is $g/2$
 (d) acceleration of A is $\frac{3}{4}g$

8. In the figure shown all the surface are smooth. All the blocks A, B and C are movable x-axis is horizontal and y-axis vertical as shown. Just after the system is released from the position as shown.

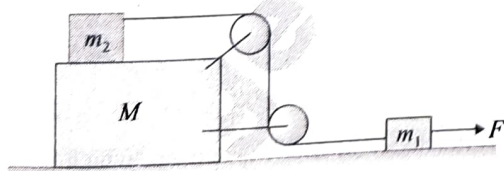


- (a) Acceleration of 'A' relative to ground is in negative y-direction
 (b) Acceleration of 'A' relative to B is in positive x-direction
 (c) The horizontal acceleration of 'B' relative to ground is in negative x-direction.
 (d) The acceleration of 'B' relative to ground directed along the inclined surface of 'C' is greater than $g \sin \theta$.

Matching Column Type

9. Match the following:

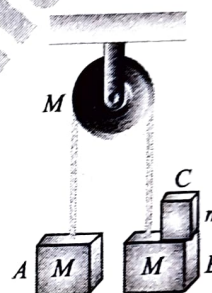
Three blocks of masses m_1 , m_2 and M are arranged as shown in figure. All the surfaces are frictionless and string is inextensible. Pulleys are light. A constant force F is applied on block of mass m_1 . Pulleys and string are light. Part of the string connecting both pulleys is vertical and part of the strings connecting pulleys with masses m_1 and m_2 is horizontal.



Column-I		Column-II	
(a)	Acceleration of mass m_1	(p)	$\frac{F}{m_1}$
(b)	Acceleration of mass m_2	(q)	$\frac{F}{m_1 + m_2}$
(c)	Acceleration of mass M	(r)	zero
(d)	Tension in the string	(s)	$\frac{m_2 F}{m_1 + m_2}$

Comprehension Type

For the following system shown assume that pulley is frictionless, string is massless (m remains on M):



10. The acceleration of the block A is

- (a) $\frac{mg}{2M + m}$ (b) $\frac{2mg}{2M + m}$
 (c) $\frac{mg}{M + 2m}$ (d) $\frac{Mg}{M + 2m}$

11. Normal reaction on m is (force on C due to B)

- (a) $\frac{M mg}{2M + m}$ (b) $\frac{2M mg}{2M + m}$
 (c) $\frac{M mg}{M + 2m}$ (d) $\frac{2M mg}{M + m}$

12. The force on the ceiling is

- (a) $\frac{(M + m) mg}{2M + m}$ (b) $\frac{(6M + 5m) mg}{M + m}$
 (c) $\frac{(M + m) mg}{M + m}$ (d) $\frac{(6M + 5m) Mg}{2M + m}$

Answers Key

Single Correct Answer Type

1. (c) 2. (a) 3. (a) 4. (b) 5. (d)
 6. (a)

Multiple Correct Answers Type

7. (b, d) 8. (a, b, c, d)

Matching Column Type

9. (a $\rightarrow$ q) (b $\rightarrow$ q) (c $\rightarrow$ r) (d $\rightarrow$ s)

Comprehension Type

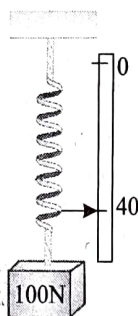
10. (a) 11. (b) 12. (d)

DPP 6.7

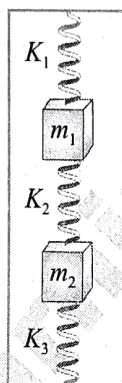
Springs

Subjective Type

1. An ideal spring, with a pointer attached to its end, hangs next to a scale. With a 100 N weight attached and in equilibrium, the pointer indicates '40' on the scale as shown. Using a 200 N weight instead results in '60' on the scale. Using an unknown weight 'X' instead results in '30' on the scale. Find the value of 'X'.



2. In an elevator a system is arranged as shown in figure. Initially elevator is at rest and the system is in equilibrium with middle spring unstretched. When the elevator accelerates upward, it was found that for the new equilibrium position (with respect to lift), the further extension in the top spring is 1.5 times that of the further compression in the bottom spring, irrespective of the value of acceleration.



- (a) Find the value of $\frac{m_1}{m_2}$ in terms of spring constants for this to happen.
 (b) If $k_1 = k_2 = k_3 = 500 \text{ N/m}$ and $m_1 = 2 \text{ kg}$ and acceleration of the elevator is 2.5 m/s^2 , find the tension in the middle spring in the final equilibrium with respect to lift.

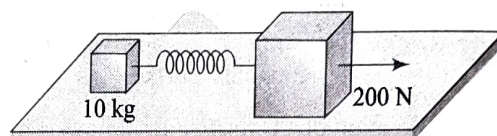
Single Correct Answer Type

3. The tension in the spring is

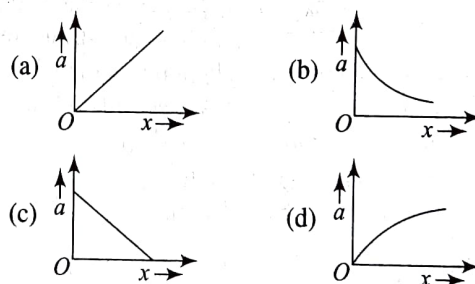
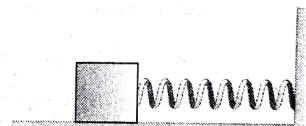


- (a) Zero (b) 2.5 N (c) 5 N (d) 10 N
4. A spring balance and a physical balance are kept in a lift. In these balances equal masses are placed. If now the lift starts moving upwards with constant acceleration, then
- (a) The reading of spring balance will increase and the equilibrium position of the physical balance will disturb
 (b) The reading of spring balance will remain unchanged and physical balance will remain in equilibrium
 (c) The reading of spring balance will decrease and physical balance will remain in equilibrium
 (d) The reading of spring balance will increase and the physical balance will remain in equilibrium

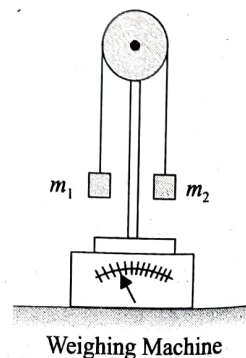
5. The masses of 10 kg and 20 kg respectively are connected by a massless spring as shown in figure. A force of 200 N acts on the 20 kg mass. At the instant shown, the 10 kg mass has acceleration 12 m/sec^2 . What is the acceleration of 20 kg mass?



- (a) 12 m/sec^2 (b) 4 m/sec^2
 (c) 10 m/sec^2 (d) Zero
6. An ideal spring is compressed and placed horizontally between a vertical fixed wall and a block free to slide over a smooth horizontal table top as shown in the figure. The system is released from rest. The graph which represents the relation between the magnitude of acceleration 'a' of the block and the distance 'x' travelled by it (as long as the spring is compressed) is



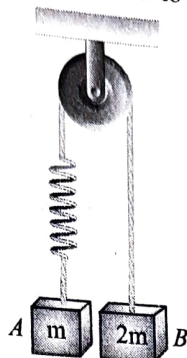
7. Two blocks of masses m_1 and m_2 , which are connected with a light string, are placed over a frictionless pulley. This set up is placed over a weighing machine, as shown. Three combination of masses m_1 and m_2 are used, in first case $m_1 = 6 \text{ kg}$ and $m_2 = 2 \text{ kg}$, in second case $m_1 = 5 \text{ kg}$ and $m_2 = 3 \text{ kg}$ and in third case $m_1 = 4 \text{ kg}$ and $m_2 = 4 \text{ kg}$. Masses are held stationary initially and then



released. If the readings of the weighing machine after the release in three cases are W_1 , W_2 and W_3 respectively then:

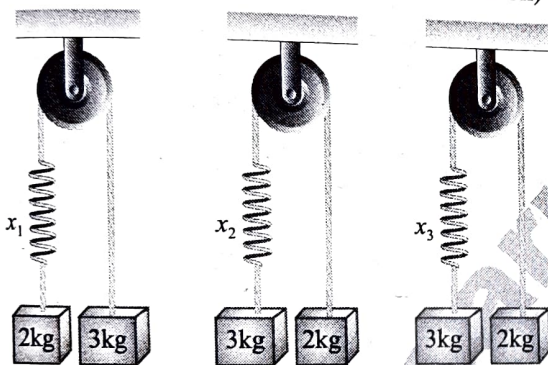
- (a) $W_1 > W_2 > W_3$ (b) $W_1 < W_2 < W_3$
 (c) $W_1 = W_2 = W_3$ (d) $W_1 = W_2 < W_3$

8. A block 'A' of mass ' m ' is attached at one end of a light spring and the other end of the spring is connected to another block 'B' of mass $2m$ through a light string as shown in the figure. 'A' is held and B is in static equilibrium. Now A is released. The acceleration of A just after that instant is ' a '. In the next case, B is held and A is in static equilibrium. Now when B is released, its acceleration immediately after the release is ' b '. The value of a/b is: (Pulley, string and the spring are massless)



- (a) 0 (b) undefined
 (c) 2 (d) $\frac{1}{2}$

9. Same spring is attached with 2 kg, 3 kg and 1 kg blocks in three different cases as shown in figure. If x_1 , x_2 and x_3 be the extensions in the spring in these cases then (Assume all the blocks to move with uniform acceleration)



- (a) $x_1 = 0$, $x_3 > x_2$ (b) $x_2 > x_1 > x_3$
 (c) $x_3 > x_1 > x_2$ (d) $x_1 > x_2 > x_3$
10. Figure shows a 5 kg ladder hanging from a string that is connected with a ceiling and is having a spring balance connected in between. A boy of mass 25 kg is climbing

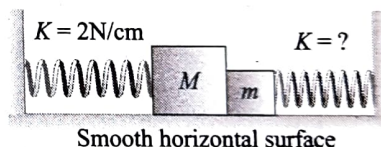
up the ladder at acceleration 1 m/s^2 . Assuming the spring balance and the string to be massless and the spring to show a constant reading, the reading of the spring balance is: (Take $g = 10 \text{ m/s}^2$)



- (a) 30 kg (b) 32.5 kg
 (c) 35 kg (d) 37.5 kg

Multiple Correct Answers Type

11. Two blocks of mass M and m , are used to compress two different massless springs as shown. The left spring is compressed by 3 cm, while the right spring is compressed by an unknown amount. The system is at rest, and all surfaces fixed and smooth. Which of the following statements are true?



- (a) The force exerted on block of mass m by the right spring is 6 N to the left.
 (b) The force exerted on block of mass m by the right spring is impossible to determine.
 (c) The net force on block of mass m is zero.
 (d) The normal force exerted by block of mass m on block of mass M is 6 N.

Answers Key

Subjective Type

1. 50 N 2. (a) $\frac{m_1}{m_2} = \frac{3k_1 + k_2}{2k_3 - k_2}$ (b) 1.25 N

Single Correct Answer Type

3. (c) 4. (d) 5. (b) 6. (c) 7. (b)
 8. (c) 9. (b) 10. (b)

Multiple Correct Answers Type

11. (a, c, d)

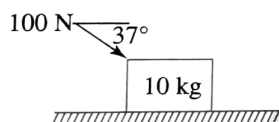
Newton's Laws of Motion II

DPP 7.1

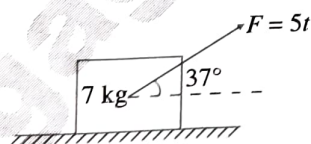
Basic Concept of Static Friction

Subjective Type

1. In the figure shown calculate the angle of friction. The block does not slide. Take $g = 10 \text{ m/s}^2$.

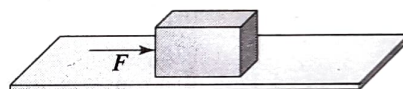


2. A block of 7 kg is placed on a rough horizontal surface and is pulled through a variable force F (in N) = $5t$, where ' t ' is time in second, at an angle of 37° with the horizontal as shown in figure. The coefficient of static friction of the block with the surface is one. If the force starts acting at $t = 0 \text{ s}$, find the time at which the block starts to slide. (Take $g = 10 \text{ m/s}^2$):

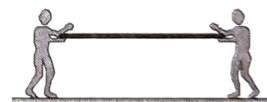


Single Correct Answer Type

3. A block of mass 2 kg is kept on the floor. The coefficient of static friction is 0.4. If a force F of 2.5 Newtons is applied on the block as shown in the figure, the frictional force between the block and the floor will be

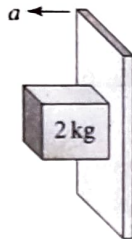


- (a) 2.5 N (b) 5 N
(c) 7.84 N (d) 10 N
4. Two persons pull each other through a massless rope in 'tug of war' game. Who will win?

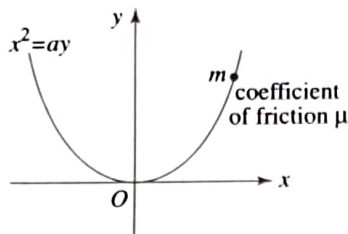


- (a) one whose weight is more
(b) one who pulls the rope with a greater force
(c) one who applies more friction force (shear force) on ground
(d) one who applies more normal force (compressive force) on ground
5. A block of mass 4 kg is kept on ground. The coefficient of friction between the block and the ground is 0.80. An external force of magnitude 30 N is applied parallel to the ground. The resultant force exerted by the ground on the block is:
(a) 40 N (b) 30 N (c) 0 N (d) 50 N
6. A block weighs W is held against a vertical wall by applying a horizontal force F . The minimum value of F needed to hold the block is
(a) Less than W (b) Equal to W
(c) Greater than W (d) Data is insufficient

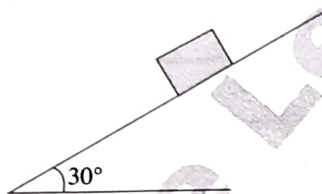
7. A rough vertical board has an acceleration 'a' so that a 2 kg block pressing against it does not fall. The coefficient of friction between the block and the board should be



- (a) $>g/a$ (b) $<g/a$
 (c) $=g/a$ (d) $>a/g$
8. A bead of mass m is located on a parabolic wire with its axis vertical and vertex directed towards downward as in figure and whose equation is $x^2 = ay$. If the coefficient of friction is μ , the highest distance above the x -axis at which the particle will be in equilibrium is



- (a) μa (b) $\mu^2 a$
 (c) $\mu^2 a/4$ (d) $2\mu a$
9. Figure shows a block kept on a rough inclined plane. The maximum external force down the incline for which the block remains at rest is 1 N while the maximum external force up the incline for which the block is at rest is 7 N. The coefficient of static friction μ is:

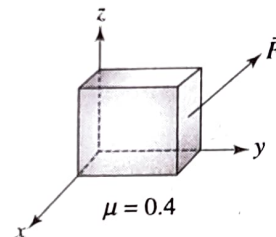


- (a) $\frac{\sqrt{3}}{2}$ (b) $\frac{1}{\sqrt{6}}$
 (c) $\sqrt{3}$ (d) $\frac{4}{3\sqrt{3}}$

10. A block of mass 20 kg is acted upon by a force $F = 30$ N at an angle 53° with the horizontal in downward direction as shown. The coefficient of friction between the block and the horizontal surface is 0.2. The friction force acting on the block by the ground is ($g = 10 \text{ m/s}^2$)
- (a) 40.0 N (b) 30.0 N
 (c) 18.0 N (d) 44.8 N

Multiple Correct Answers Type

11. When a bicycle is in motion, the force of friction exerted by the ground on the two wheels is such that it acts
- (a) In the backward direction on the front wheel and in the forward direction on the rear wheel
 (b) In the forward direction on the front wheel and in the backward direction on the rear wheel
 (c) In the backward direction on both front and the rear wheels
 (d) In the forward direction on both front and the rear wheels
12. A solid cube of mass 5 kg is placed on a rough horizontal surface, in xy -plane as shown. The friction coefficient between the surface and the cube is 0.4. An external force $\vec{F} = 6\hat{i} + 8\hat{j} + 20\hat{k}$ N is applied on the cube. (use $g = 10 \text{ m/s}^2$)



- (a) The block starts slipping over the surface
 (b) The friction force on the cube by the surface is 10 N.
 (c) The friction force acts in xy -plane at angle 127° with the positive x -axis in clockwise direction.
 (d) The contact force exerted by the surface on the cube is $10\sqrt{10}$ N.

Answers Key

Subjective Type

1. $\theta = \tan^{-1} \frac{1}{2}$
 2. 10 sec

Single Correct Answer Type

3. (a) 4. (c) 5. (d) 6. (c)

7. (a) 8. (c) 9. (d) 10. (c)

Multiple Correct Answers Type

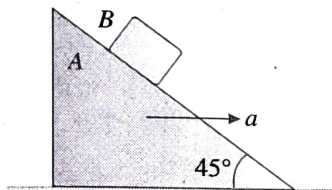
11. (a, c) 12. (b, c, d)

DPP 7.2

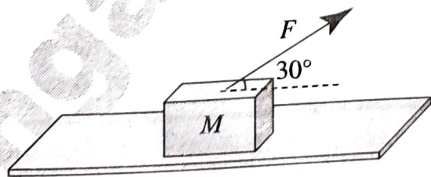
Analysis of Static and Kinetic Friction 1

Single Correct Answer Type

1. A heavy body of mass 25 kg is to be dragged along a horizontal plane ($\mu = 1/\sqrt{3}$). The least force required is
(a) 25 kgf (b) 2.5 kgf
(c) 12.5 kgf (d) 6.25 kgf
2. If the coefficient of friction between A and B is μ , the maximum horizontal acceleration of the wedge A for which B will remain at rest w.r.t. the wedge is:

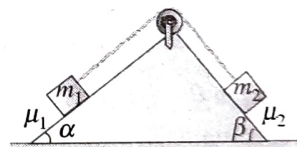


- (a) μg (b) $g \left(\frac{1+\mu}{1-\mu} \right)$
(c) $\frac{g}{\mu}$ (d) $g \left(\frac{1-\mu}{1+\mu} \right)$
3. A 60 kg body is pushed with just enough force to start it moving across a floor and the same force continues to act afterwards. The coefficient of static friction and sliding friction are 0.5 and 0.4 respectively. The acceleration of the body is
(a) 6 m/s^2 (b) 4.9 m/s^2
(c) 3.92 m/s^2 (d) 1 m/s^2
4. A block of mass $M = 5 \text{ kg}$ is resting on a rough horizontal surface for which the coefficient of friction is 0.2. When a force $F = 40 \text{ N}$ is applied, the acceleration of the block will be ($g = 10 \text{ m/s}^2$)
(a) 5.73 m/sec^2 (b) 8.0 m/sec^2
(c) 3.17 m/sec^2 (d) 10.0 m/sec^2

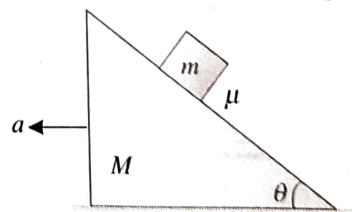


5. A fireman of mass 60 kg slides down a pole. He is pressing the pole with a force of 600 N. The coefficient of friction between the hands and the pole is 0.5, with what acceleration will the fireman slide down ($g = 10 \text{ m/s}^2$)
(a) 1 m/s^2 (b) 2.5 m/s^2
(c) 10 m/s^2 (d) 5 m/s^2

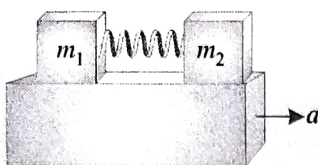
6. The force required just to move a body up an inclined plane is double the force required just to prevent the body sliding down. If the coefficient of friction is 0.25, the angle of inclination of the plane is
(a) 37° (b) 45° (c) 30° (d) 53°
7. A force of 750 N is applied to a block of mass 102 kg to prevent it from sliding on a plane with an inclination angle 30° with the horizontal. If the coefficients of static friction and kinetic friction between the block and the plane are 0.4 and 0.3 respectively, then the frictional force acting on the block is
(a) 750 N (b) 500 N
(c) 345 N (d) 250 N
8. Two blocks of masses m_1 and m_2 connected by a string are placed gently over a fixed inclined plane, such that the tension in the connecting string is initially zero. The coefficient of friction between m_1 and inclined plane is μ_1 ; between m_2 and the inclined plane is μ_2 . The tension in the string shall continue to remain zero if



- (a) $\mu_1 > \tan \alpha$ and $\mu_2 < \tan \beta$
(b) $\mu_1 < \tan \alpha$ and $\mu_2 > \tan \beta$
(c) $\mu_1 > \tan \alpha$ and $\mu_2 > \tan \beta$
(d) $\mu_1 > \tan \alpha$ and $\mu_2 > \tan \beta$
9. A block of mass m is at rest relative to the stationary wedge of mass M . The coefficient of friction between block and wedge is μ . The wedge is now pulled horizontally with acceleration 'a' as shown in figure. Then the minimum magnitude of 'a' for the friction between block and wedge to be zero is:



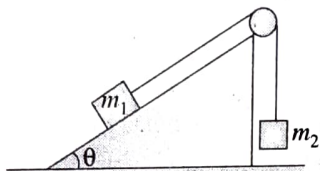
- (a) $g \tan \theta$ (b) $\mu g \tan \theta$
(c) $g \cot \theta$ (d) $\mu g \cot \theta$
10. Two blocks of masses m_1 and m_2 are connected with a massless unstretched spring and placed over a plank moving with an acceleration 'a' as shown in figure. The coefficient of friction between the blocks and platform is μ .



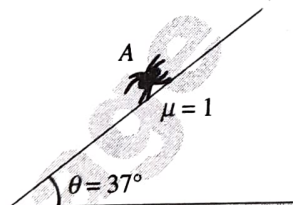
- (a) spring will be stretched if $a > \mu g$
- (b) spring will be compressed if $a \leq \mu g$
- (c) spring will neither be compressed nor be stretched for $a \leq \mu g$
- (d) spring will be in its natural length under all conditions

Multiple Correct Answers Type

11. Two blocks of masses m_1 and m_2 are connected by a string of negligible mass which passes over a frictionless pulley fixed on the top of an inclined plane as shown in figure. The coefficient of friction between m_1 and plane is μ .



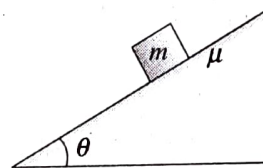
- (a) If $m_1 = m_2$ the mass m_1 first begin to move up inclined plane when the angle of inclination is θ , then $\mu = \tan \theta$.
 - (b) If $m_1 = m_2$ the mass m_1 first begin to move up the inclined plane when the angle of inclination is θ , then $\mu = \sec \theta - \tan \theta$.
 - (c) If $m_1 = 2m_2$ the mass m_1 first begin to slide down the plane if $\mu = 2 \tan \theta$.
 - (d) If $m_1 = 2m_2$ the mass m_1 first begin to slide down the plane if $\mu = \tan \theta - \frac{1}{2} \sec \theta$.
12. An insect of mass m , starts moving on a rough inclined surface from point A. As the surface is very sticky, the coefficient of friction between the insect and the incline is $\mu = 1$. Assume that it can move in any direction; up the incline or down the incline then



- (a) The maximum possible acceleration of the insect can be 14 m/sec^2
- (b) The maximum possible acceleration of the insect can be 2 m/sec^2
- (c) The insect can move with a constant velocity
- (d) The insect cannot move with a constant velocity

Comprehension Type

A block of mass m is placed on a rough inclined plane. The coefficient of friction between the block and the plane is μ and the inclination of the plane is θ . Initially $\theta = 0$ and the block will remain stationary on the plane. Now the inclination θ is gradually increased. The block presses the inclined plane with a force $mg \cos \theta$. So welding strength between the block and inclined is $\mu mg \cos \theta$, and the pulling forces is $mg \sin \theta$. As soon as the pulling force is greater than the welding strength, the welding breaks and the block starts sliding, the angle θ for which the block starts sliding is called angle of repose (λ). During the contact, two contact forces are acting between the block and the inclined plane. The pressing reaction (Normal reaction) and the shear reaction (frictional force). The net contact force will be resultant of both.



Answer the following questions based on above comprehension:

13. If the entire system, were accelerated upward with acceleration ' a ', the angle of repose, would:
- (a) increase
 - (b) decrease
 - (c) remain same
 - (d) increase if $a > g$
14. For what value of θ will the block slide on the inclined plane:
- (a) $\theta > \tan^{-1} \mu$
 - (b) $\theta < \tan^{-1} \mu$
 - (c) $\theta > \cot^{-1} \mu$
 - (d) $\theta < \cot^{-1} \mu$
15. If $\mu = 3/4$ then what will be frictional force (shear force) acting between the block and inclined plane when $\theta = 30^\circ$:
- (a) $\frac{3\sqrt{3}}{8} mg$
 - (b) $\frac{mg}{2}$
 - (c) $\frac{\sqrt{3}}{2} mg$
 - (d) zero

Answers Key

Single Correct Answer Type

1. (c) 2. (b) 3. (d) 4. (a) 5. (d)
6. (a) 7. (d) 8. (c) 9. (c) 10. (d)

Multiple Correct Answers Type

11. (b, d) 12. (a, c)

Comprehension Type

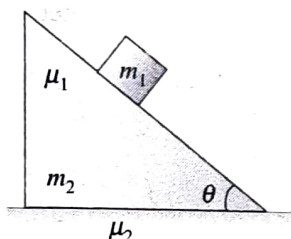
13. (c) 14. (a) 15. (b)

DPP 7.3

Analysis of Static and Kinetic Friction 2

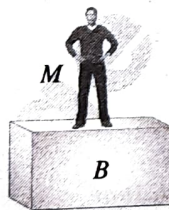
Subjective Type

1. A block of mass m_1 is placed on a wedge of an angle θ , as shown. The block is moving over the inclined surface of the wedge. Friction coefficient between the block and the wedge is μ_1 , where as it is μ_2 between the wedge and the horizontal surface. If $\mu_1 = \frac{1}{2}$, $\theta = 45^\circ$, $m_1 = 4$ kg, $m_2 = 5$ kg and $g = 10$ m/s², find minimum value of μ_2 so that the wedge remains stationary on the surface.

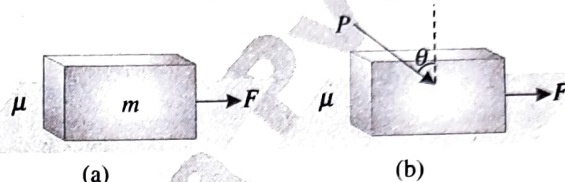


Single Correct Answer Type

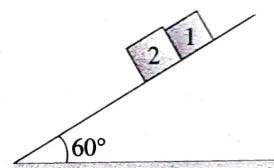
2. As shown in the figure, M is a man of mass 60 kg standing on a block of mass 40 kg kept on ground. The co-efficient of friction between the feet of the man and the block is 0.3 and that between B and the ground is 0.1. If the man accelerates with an acceleration 2 m/s² in the forward direction, then:



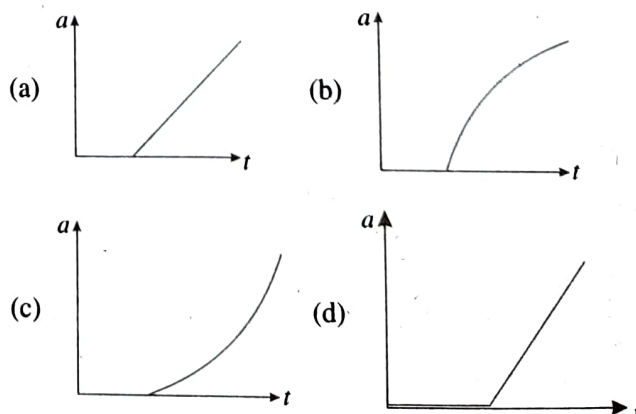
- (a) it is not possible
 - (b) B will move backwards with an acceleration 0.5 m/s²
 - (c) B will not move
 - (d) B will move forward with an acceleration 0.5 m/s².
3. The coefficient of friction between the block and the horizontal surface is μ . The block moves towards right under action of horizontal force F (figure a). Sometime later another force P is applied to the block making an angle θ (such that $\tan \theta = \mu$) with vertical as shown in (figure b). After application of force P , the acceleration of block shall



- (a) increase
 - (b) decrease
 - (c) remains same
 - (d) information insufficient for drawing inference
4. In the figure shown if friction co-efficient of block 1 and 2 with inclined plane is $\mu_1 = 0.5$ and $\mu_2 = 0.4$ respectively, then find out the correct statement.

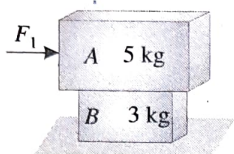


- (a) both block will move together
 - (b) both block will move separately
 - (c) there is a non-zero contact force between two blocks
 - (d) none of these
5. A force $F = 2t$ (where t is time in seconds) is applied at $t = 0$ sec to the block of mass m placed on a rough horizontal surface. The coefficient of static and kinetic friction between the block and surface are μ_s and μ_k respectively. Which of the following graphs best represents the acceleration vs time of the block ($\mu_s > \mu_k$)?



Multiple Correct Answers Type

6. A block A (5 kg) rests over another block B (3 kg) placed over a smooth horizontal surface. There is friction between A and B. A horizontal force F_1 gradually increasing from zero to a maximum is applied to A so that the blocks move together without relative motion. Instead of this another horizontal force F_2 , gradually increasing from zero to a maximum is applied to B so that the blocks move together without relative motion. Then

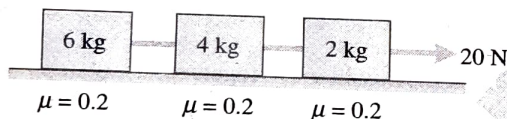


- (a) $F_1(\text{max}) = F_2(\text{max})$
 (b) $F_1(\text{max}) > F_2(\text{max})$
 (c) $F_1(\text{max}) < F_2(\text{max})$
 (d) $F_1(\text{max}) : F_2(\text{max}) = 5 : 3$

Comprehension Type

For Problems 7–9

Three blocks of masses 6 kg, 4 kg and 2 kg are pulled on a rough surface by applying a constant force 20 N. The values of coefficient of friction between blocks and surface are shown in figure.



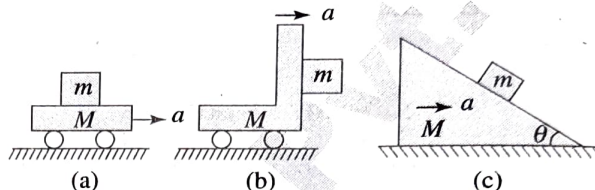
7. In the arrangement shown tension in the string connecting 4 kg and 6 kg masses is
 (a) 8 N (b) 12 N
 (c) 6 N (d) 4 N
8. Friction force on 4 kg block is
 (a) 4 N (b) 6 N
 (c) 12 N (d) 8 N

9. Friction force on 6 kg block is

- (a) 12 N (b) 8 N
 (c) 6 N (d) 4 N

For Problems 10–12

In the situations given in figures (a), (b) and (c) the block of mass m does not slide relative to the accelerating frame. If μ_s = coefficient of static friction between the block and accelerating frame, in each case, find the range of accelerations.



10. In case (a)

- (a) $a \leq \mu_s g$ (b) $a \leq \frac{g}{\mu_s}$
 (c) $a \leq \frac{gm}{\mu_s M}$ (d) $a \leq \frac{gM}{\mu_s m}$

11. In case (b)

- (a) $a \leq \mu_s g$ (b) $a \geq \frac{g}{\mu_s}$
 (c) $a \leq \frac{gm}{\mu_s M}$ (d) $a \leq \frac{gM}{\mu_s m}$

12. In case (c)

- (a) $a \leq g \left(\frac{\sin \theta - \mu \cos \theta}{\cos \theta + \mu \sin \theta} \right)$
 (b) $a \leq g \left(\frac{\cos \theta + \mu \sin \theta}{\sin \theta - \mu \cos \theta} \right)$
 (c) $a \leq g \left(\frac{\cos \theta - \mu \sin \theta}{\sin \theta + \mu \cos \theta} \right)$
 (d) $a \leq g \left(\frac{\sin \theta + \mu \cos \theta}{\cos \theta - \mu \sin \theta} \right)$

Answers Key

Subjective Type

1. $1/8$

Single Correct Answer Type

2. (b) 3. (c) 4. (b) 5. (d)

Multiple Correct Answers Type

6. (b, d)

Comprehension Type

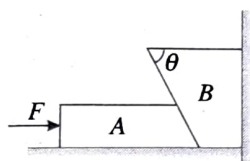
7. (a) 8. (d) 9. (b) 10. (a) 11. (b)
 12. (d)

DPP 7.4

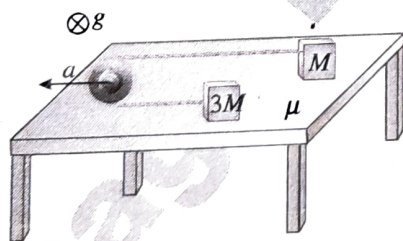
Analysis of Friction on Two Surfaces 1

Subjective Type

1. In the figure shown, the coefficient of static friction between B and the wall is $2/3$ and the coefficient of kinetic friction between B and the wall is $1/3$. Other contacts are smooth. Find the minimum force ' F ' required to lift B , up. Now if the force applied on A is slightly increased than the calculated value of minimum force, then find the acceleration of B . Mass of A is 2 m and the mass of B is m . Take $\tan \theta = \frac{3}{4}$.



2. Two blocks of mass M and $3M$ (in kg) are connected by an inextensible light thread which passes over a light frictionless pulley. The whole system is placed over a fixed horizontal table as shown. The coefficient of friction between the blocks and table surface is μ . The pulley is pulled by a string attached to its centre and accelerated to left with acceleration a (m/s^2). Assume that gravity acts with constant acceleration g (m/s^2) downwards through the plane of table. Then:

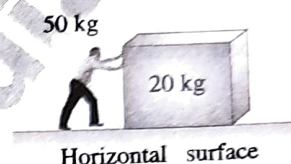


- (a) Find the horizontal acceleration of both the blocks (Assume that both the blocks are moving).
(b) What is the maximum acceleration a , for which the block of mass $3M$ will remain stationary?

Single Correct Answer Type

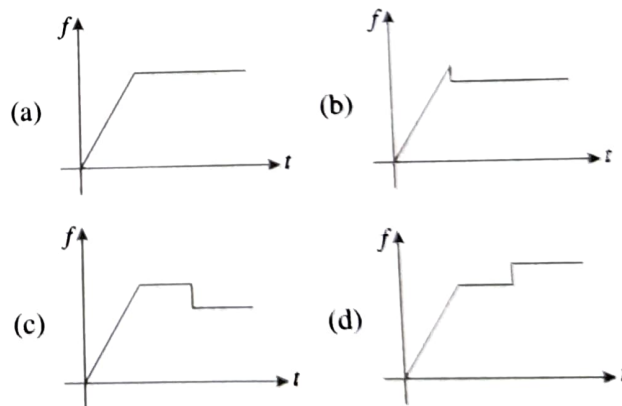
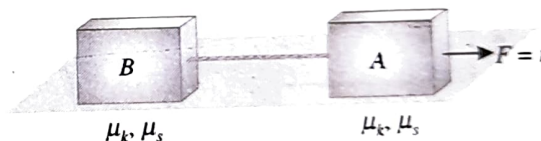
3. A boy of mass 50 kg produces an acceleration of 2 m/s^2 in a block of mass 20 kg by pushing it in horizontal

direction. The boy moves with the block such that boy and the block have same acceleration. There is no friction between the block and fixed horizontal surface but there is friction between foot of the boy and horizontal surface. Find friction force (in Newton) exerted by the horizontal surface on the boy.

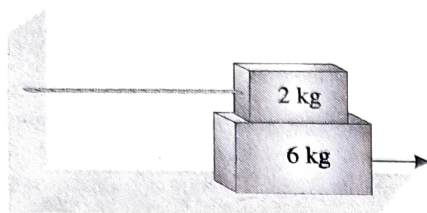


- (a) 120
(b) 140
(c) 160
(d) 200

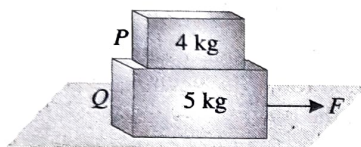
4. A force $F = t$ is applied to a block A as shown in figure, where t is time in seconds. The force is applied at $t = 0$ seconds when the system was at rest. Which of the following graph correctly gives the frictional force between A and horizontal surface as a function of time t . [Assume that at $t = 0$, tension in the string connecting the two blocks is zero].



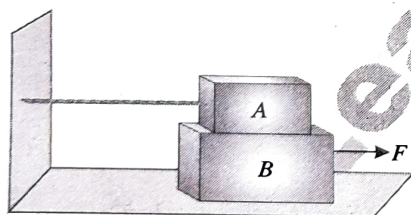
5. With reference to the figure shown, if the coefficient of friction at the surfaces is 0.42 , then the force required to pull out the 6.0 kg block with an acceleration of 1.50 m/s^2 will be:



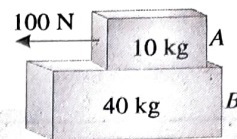
- (a) 36 N (b) 24 N
(c) 84 N (d) 51 N
6. The coefficient of friction between 4 kg and 5 kg blocks is 0.2 and between 5 kg block and ground is 0.1 respectively. Choose the correct statements.



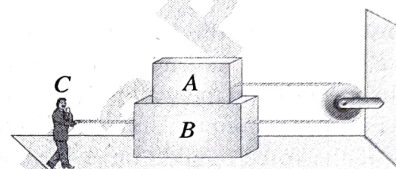
- (a) Minimum force needed to cause system to move is 17 N
(b) When force is 4 N static friction at all surfaces is 4 N to keep system at rest
(c) Maximum acceleration of 4 kg block is 2 m/s^2
(d) Slipping between 4 kg and 5 kg blocks start when F is 17 N
7. A block A with mass 100 kg is resting on another block B of mass 200 kg. As shown in figure a horizontal rope tied to a wall holds it. The coefficient of friction between A and B is 0.2 while coefficient of friction between B and the ground is 0.3. The minimum required force F to start moving B will be



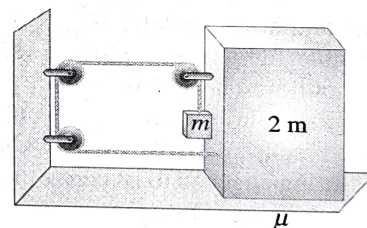
- (a) 900 N (b) 100 N
(c) 1100 N (d) 1200 N
8. A body B lies on a smooth horizontal table and another body A is placed on B. The coefficient of friction between A and B is μ . What acceleration given to B will cause slipping to occur between A and B
- (a) μg (b) g/μ
(c) μ/g (d) $\sqrt{\mu g}$
9. A 40 kg slab rests on a frictionless floor as shown in the figure. A 10 kg block rests on the top of the slab. The static coefficient of friction between the block and slab is 0.60 while the kinetic friction is 0.40. The 10 kg block is acted upon by a horizontal force 100 N. If $g = 9.8 \text{ m/s}^2$, the resulting acceleration of the slab will be



- (a) 1 m/s^2 (b) 1.5 m/s^2
(c) 2 m/s^2 (d) 6 m/s^2
10. In the figure $m_A = m_B = m_C = 60 \text{ kg}$. The coefficient of friction between C and ground is 0.5, B and ground is 0.3, A and B is 0.4. C is pulling the string with the maximum possible force without moving. Then tension in the string connected to A will be:



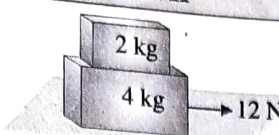
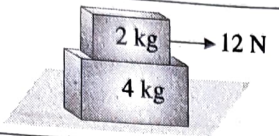
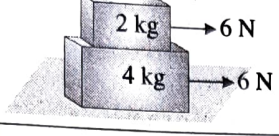
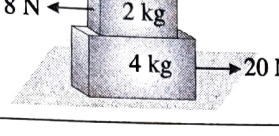
- (a) 120 N (b) 60 N
(c) 100 N (d) zero
11. In the system shown in figure the friction coefficient between ground and bigger block is μ . There is no friction between both the blocks. The string connecting both the block is light; all three pulleys are light and frictionless. Then the minimum limiting value of μ so that the system remains in equilibrium is



- (a) $\frac{1}{2}$ (b) $\frac{1}{3}$
(c) $\frac{2}{3}$ (d) $\frac{3}{2}$

Matching Column Type

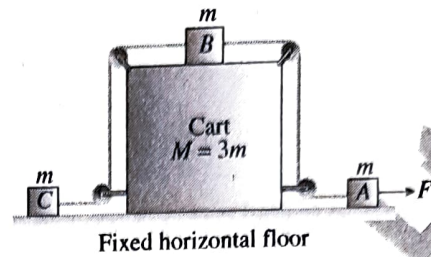
12. Column II gives certain situations involving two blocks of mass 2 kg and 4 kg. The 4 kg block lies on a smooth horizontal table. There is sufficient friction between both the block and there is no relative motion between both the blocks in all situations. Horizontal forces act on one or both blocks as shown. Column I gives certain statement related to figures given in column II. Match the statements in column I with the figure in column II and indicate your answer by darkening appropriate bubbles in the 4×4 matrix given in OMR.

Column I	Column II
(a) Magnitude of frictional force is maximum.	(p) 
(b) Magnitude of friction force is least.	(q) 
(c) Friction force on 2 kg block is towards right.	(r) 
(d) Friction force on 2 kg block is towards left.	(s) 

Comprehension Type

For Problems 13–15

A block B is placed over a cart which in turn lies over a smooth horizontal floor. Block A and block C are connected to block B with light inextensible strings passing over light frictionless pulleys fixed to the cart as shown. Initially the blocks and the cart are at rest. All the three blocks have mass m and the cart has mass $M(M = 3m)$. Now a constant horizontal force of magnitude F is applied to block A towards right.



13. Assuming friction to be absent everywhere, the magnitude of acceleration of cart at the shown instant is

- (a) $\frac{F}{6m}$ (b) $\frac{F}{4m}$
(c) $\frac{F}{3m}$ (d) 0

14. Taking friction to be absent everywhere the magnitude of tension in the string connecting block B and block C is

- (a) $\frac{F}{9}$ (b) $\frac{F}{6}$
(c) $\frac{F}{3}$ (d) $\frac{2F}{3}$

15. Let the coefficient of friction between block B and cart is μ ($\mu > 0$) and friction is absent everywhere else. Then the maximum value of force F applied to block A such that there is no relative acceleration between block B and cart is

- (a) μmg (b) $2\mu mg$
(c) $3\mu mg$ (d) $4\mu mg$

Answers Key

Subjective Type

1. (i) $F_{\min} = \frac{3}{4}mg$ (ii) $b = \frac{3g}{7}$
2. (a) $a_1 = \frac{3a + \mu g}{2}$, $a_2 = \frac{a - \mu g}{2}$
(b) μg

Single Correct Answer Type

3. (b) 4. (c) 5. (d) 6. (c) 7. (c)
8. (a) 9. (a) 10. (d) 11. (c)

Matching Column Type

12. (A $\rightarrow$ s) (B $\rightarrow$ r) (C $\rightarrow$ p, s) (D $\rightarrow$ q, r)

Comprehension Type

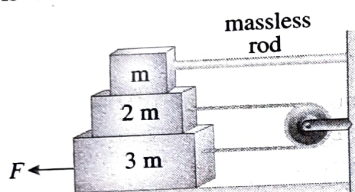
13. (d) 14. (c) 15. (b)

DPP 7.5

Analysis of Friction on Multiple Surfaces 2

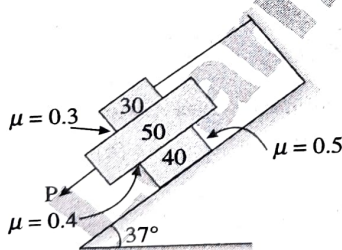
Subjective Type

1. Three blocks are connected as shown in the figure. Calculate the minimum force required to move the body with constant velocity. The coefficient of friction at all surfaces is 0.25.



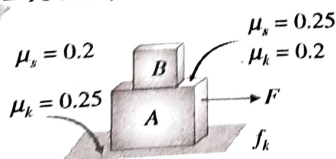
[Assume that rod does not exert force in vertical direction]

2. The three flat blocks in the figure are positioned on the 37° incline and a force parallel to the inclined plane is applied to the middle block. The upper block is prevented from moving by a wire which attaches it to the fixed support. The masses of three blocks in kg and coefficient of static friction for each of the three pairs of contact surfaces is shown in the figure. Determine the maximum value which force P may have before slipping take place anywhere.

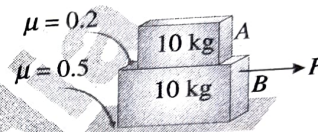


Single Correct Answer Type

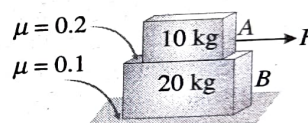
3. Block B of mass 2 kg rests on block A of mass 10 kg. All surfaces are rough with the value of coefficient of friction as shown in the figure. Find the minimum force F that should be applied on block A to cause relative motion between A and B . ($g = 10 \text{ m/s}^2$)



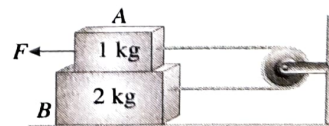
- (a) 24 N (b) 30 N (c) 48 N (d) 60 N
4. Two blocks A and B are as shown in figure. The minimum horizontal force F applied on block ' B ' for which slipping begins at ' B ' and ground is:



- (a) 100 N (b) 120 N
(c) 50 N (d) 140 N
5. In given diagram what is the minimum value of a horizontal external force F on Block ' A ' so that block ' B ' will slide on ground is:

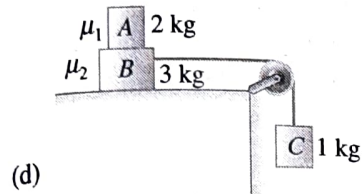
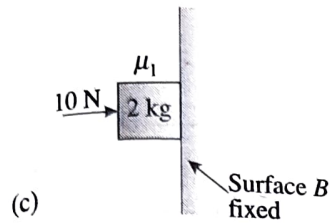
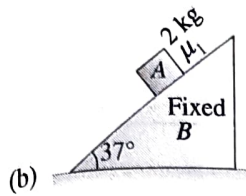


- (a) 30 N (b) 20 N
(c) 10 N (d) Not possible
6. In the previous question the minimum force ' F ' required, so that block ' A ' will slip on block ' B ' is:
- (a) 30 N (b) 20 N
(c) 10 N (d) Not possible
7. Two blocks A (1 kg) and B (2 kg) are connected by a string passing over a smooth pulley as shown in the figure. B rests on rough horizontal surface and A rest on B . The coefficient of friction between A and B is the same as that between B and the horizontal surface. The minimum horizontal force F required to move A to the left is 25 N. The coefficient of friction is: [$g = 10 \text{ m/s}^2$]

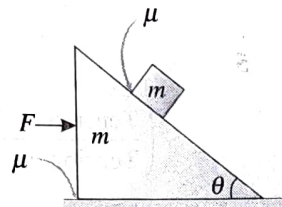


- (a) 0.67 (b) 0.5 (c) 0.4 (d) 0.25
8. In which of the following cases the friction force between ' A ' and ' B ' is maximum. In all cases $\mu_1 = 0.5$, $\mu_2 = 0$.

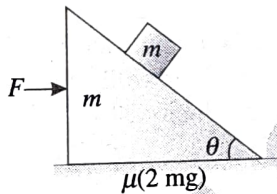




9. In the situation shown in figure a wedge of mass m is placed on a rough surface, on which a block of equal mass is placed on the inclined plane of wedge. Friction coefficient between plane and the block and the ground and the wedge (μ). An external force F is applied horizontally on the wedge. Given that m does not slide on incline due to its weight.



The value of F at which wedge will start slipping is:

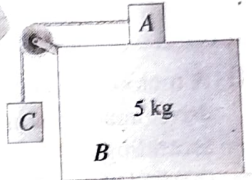


- (a) $= \mu mg$ (b) $= (3/2) \mu mg$
 (c) $> 2\mu mg$ (d) $< \mu mg$
10. The value of F at which no friction will act on block on inclined plane, is:
- (a) $2\mu mg$ (b) $2\mu mg + 2mg \tan \theta$
 (c) $2\mu mg + mg \tan \theta$ (d) $2\mu mg + mg \sin \theta$
11. The minimum value of acceleration of wedge for which the block starts sliding on the wedge, is:

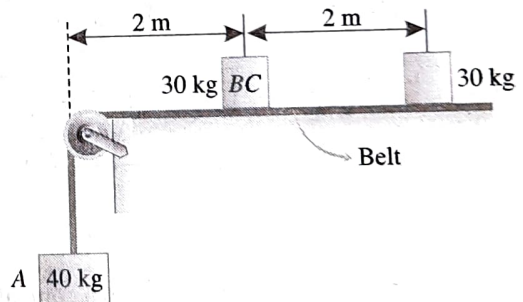
- (a) $g \left(\frac{\cos \theta + \mu \sin \theta}{\sin \theta - \mu \cos \theta} \right)$ (b) $g \left(\frac{\sin \theta + \mu \cos \theta}{\cos \theta - \mu \sin \theta} \right)$
 (c) $g \left(\frac{\sin \theta - \mu \cos \theta}{\sin \theta + \mu \cos \theta} \right)$ (d) $g \left(\frac{\cos \theta - \mu \sin \theta}{\sin \theta + \mu \cos \theta} \right)$

Multiple Correct Answers Type

12. All the blocks shown in the figure are at rest. The pulley is smooth and the strings are light. Coefficient of friction at all the contacts is 0.2. A frictional force of 10 N acts between A and B. The block A is about to slide on block B. The normal reaction and frictional force exerted by the ground on the block B is.



- (a) The normal reaction exerted by the ground on the block B is 110 N
 (b) The normal reaction exerted by the ground on the block B is 50 N
 (c) The frictional force exerted by the ground on the block B is 20 N
 (d) The frictional force exerted by the ground on the block B is zero
13. Two 30 kg blocks rest on a massless belt which passes over a fixed pulley and is attached to a 40 kg block. If coefficient of friction between the belt and the table as well as between the belt and the blocks B and C is μ and the system is released from rest from the position shown, the speed with which the block B falls off the belt is



- (a) $2\sqrt{2}$ m/s if $\mu = 0.2$ (b) $\sqrt{2}$ m/s if $\mu = 0.2$
 (c) 2 m/s if $\mu = 0.5$ (d) 2.5 m/s if $\mu = 0.5$

Answers Key

Subjective Type

1. $F = 13/4 mg$

2. $P = 12 N$

Single Correct Answer Type

3. (c) 4. (a) 5. (d) 6. (b) 7. (b)
 8. (d) 9. (c) 10. (b) 11. (b)

Multiple Correct Answers Type

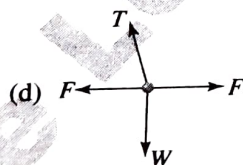
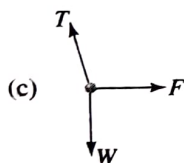
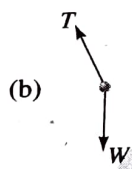
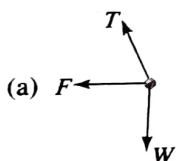
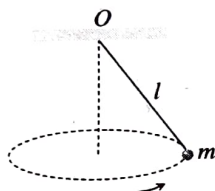
12. (a, d) 13. (a, c)

DPP 7.6

Dynamics of Circular Motion

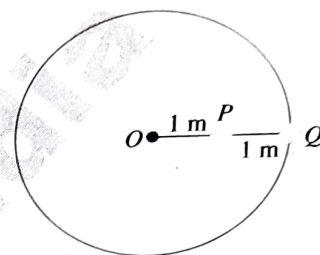
Single Correct Answer Type

1. A motorcycle is going on an overbridge of radius R . The driver maintains a constant speed. As the motorcycle is ascending on the overbridge, the normal force on it
 - (a) Increases
 - (b) Decreases
 - (c) Remains the same
 - (d) Fluctuates
2. A point mass m is suspended from a light thread of length l , fixed at O , is whirled in a horizontal circle at constant speed as shown. From your point of view, stationary with respect to the mass, the forces on the mass are



3. A particle describes a horizontal circle in a conical funnel whose inner surface is smooth with speed of 0.5 m/s . What is the height of the plane of circle from vertex of the funnel?
 - (a) 0.25 cm
 - (b) 2 cm
 - (c) 4 cm
 - (d) 2.5 cm
4. A particle is moving in a vertical circle with constant speed. The tensions in the string when passing through two positions at angles 30° and 60° from vertical (lowest position) are T_1 and T_2 respectively. Then
 - (a) $T_1 = T_2$
 - (b) $T_2 > T_1$
 - (c) $T_1 > T_2$
 - (d) Tension in the string always remains the same

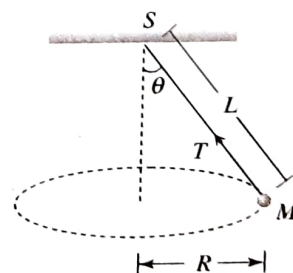
5. Two spheres of equal masses are attached to a string of length 2 m as shown in figure. The string and the spheres are then whirled in a horizontal circle about O at a constant rate. What is the value of the ratio:



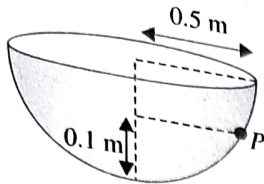
$\left(\frac{\text{Tension in the string between } P \text{ and } Q}{\text{Tension in the string between } P \text{ and } O} \right)?$

- (a) $\frac{1}{2}$
- (b) $\frac{2}{3}$
- (c) $\frac{3}{2}$
- (d) 2

6. The maximum and minimum tension in the string whirling in a circle of radius 2.5 m with constant velocity are in the ratio $5 : 3$ then its velocity is
 - (a) 10 m/s
 - (b) 7 m/s
 - (c) 15 m/s
 - (d) 5 m/s
7. A string of length L is fixed at one end and carries a mass M at the other end. The string makes $2/\pi$ revolutions per second around the vertical axis through the fixed end as shown in the figure, then tension in the string is



- (a) ML
 - (b) $2 ML$
 - (c) $4 ML$
 - (d) $16 ML$
8. A small mass of 10 g lies in a hemispherical bowl of radius 0.5 m at a height of 0.1 m from the bottom of the bowl. The mass will be in equilibrium if the bowl rotates at an



- (a) $\frac{10}{\sqrt{3}}$ rad/s
 (b) $10\sqrt{3}$ rad/s
 (c) 5 rad/s
 (d) None of these

Multiple Correct Answers Type

9. A car of mass M is moving on a horizontal circular path of radius R . At an instant its speed is v and is increasing at constant rate β .
- (a) The net acceleration of the car is towards the centre of its path.
 (b) The magnitude of the frictional force on the car is greater than $\frac{Mv^2}{R}$.
 (c) The friction coefficient between the ground and the car is not less than $\frac{\beta}{g}$.
 (d) The friction coefficient between the ground and the car is not less than $\frac{v^2}{Rg}$.
10. A body is revolving with a constant speed along a circle. If its direction of motion is reversed but the speed remains the same, then which of the following statement is true
- (a) The centripetal force will not suffer any change in magnitude
 (b) The centripetal force will have its direction reversed
 (c) The centripetal force will not suffer any change in direction
 (d) The centripetal force would be doubled

Matching Column Type

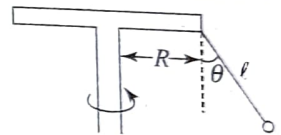
11. A motorcycle moves around a vertical circle with a constant speed under the influence of the force of gravity $\vec{w}$, friction between wheel and track $\vec{f}$ and normal reaction between wheel and track $\vec{N}$:

Column I		Column II	
(p)	Constant magnitude	(a)	$\vec{N}$
(q)	Directed towards or away from centre when value is non zero	(b)	$\vec{N} + \vec{f}$
(r)	Total reaction force by track	(c)	$\vec{f} + \vec{w}$
(s)	When motion is along vertical the value is zero	(d)	$\vec{N} + \vec{w} + \vec{f}$

Comprehension Type

For Problems 12 and 13

A pendulum bob of mass m hangs from one end of a horizontal rod which is rotating about vertical axis with an unknown angular speed ω such that the light inextensible string of length l of the pendulum makes a constant angle θ with vertical. Find the:



12. angular speed ω

(a) $\omega = \sqrt{\frac{g \tan \theta}{R + l \sin \theta}}$ (b) $\omega = \sqrt{\frac{g \tan \theta}{R + l \tan \theta}}$
 (c) $\omega = \sqrt{\frac{g \cot \theta}{R + l \sin \theta}}$ (d) $\omega = \sqrt{\frac{g \tan \theta}{R + l \cos \theta}}$

13. tension in the string

(a) $T = mg \tan \theta$ (b) $T = mg \sec \theta$
 (c) $T = mg \sin \theta \cdot \cos \theta$ (d) $T = mg \cot \theta$

Answers Key

Single Correct Answer Type

1. (a) 2. (c) 3. (d) 4. (c) 5. (b)
 6. (a) 7. (d) 8. (c)

Multiple Correct Answers Type

9. (b, c, d) 10. (a, c)

Matching Column Type

11. (p $\rightarrow$ d) (q $\rightarrow$ a, c, d) (r $\rightarrow$ b) (s $\rightarrow$ c)

Comprehension Type

12. (a) 13. (b)

Work, Power, and Energy

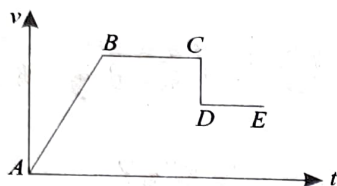
DPP 8.1

Concept of Work Done

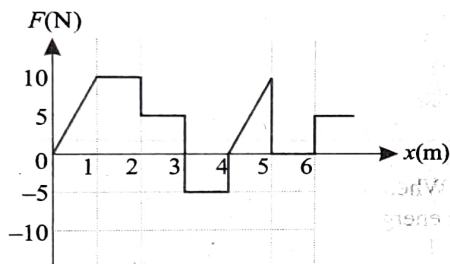
Single Correct Answer Type

- A body of mass m kg is lifted by a man to a height of one metre in 30 sec. Another man lifts the same mass to the same height in 60 sec. The work done by them are in the ratio
 - 1 : 2
 - 1 : 1
 - 2 : 1
 - 4 : 1
- A body of mass m is moving in a circle of radius r with a constant speed v . The force on the body is $\frac{mv^2}{r}$ and is directed towards the centre. What is the work done by this force in moving the body over half the circumference of the circle
 - $\frac{mv^2}{\pi r^2}$
 - Zero
 - $\frac{mv^2}{r^2}$
 - $\frac{\pi r^2}{mv^2}$
- A body of mass 6 kg is under a force which causes displacement in it given by $S = \frac{t^2}{4}$ metres where t is time. The work done by the force in 2 seconds is
 - 12 J
 - 9 J
 - 6 J
 - 3 J
- A particle moves under the effect of a force $F = Cx$ from $x = 0$ to $x = x_1$. The work done in the process is
 - Cx_1^2
 - $\frac{1}{2}Cx_1^2$
 - Cx_1
 - Zero
- A cord is used to lower vertically a block of mass M by a distance d with constant downward acceleration $\frac{g}{4}$. Work done by the cord on the block is
 - $Mg\frac{d}{4}$
 - $3Mg\frac{d}{4}$
 - $-3Mg\frac{d}{4}$
 - Mgd
- Two springs have their force constant as k_1 and k_2 ($k_1 > k_2$). When they are stretched by the same force
 - No work is done in case of both the springs
 - Equal work is done in case of both the springs
 - More work is done in case of second spring
 - More work is done in case of first spring
- A body of mass 3 kg is under a force, which causes a displacement in it is given by $S = \frac{t^3}{3}$ (in m). Find the work done by the force in first 2 seconds
 - 2 J
 - 3.8 J
 - 5.2 J
 - 24 J

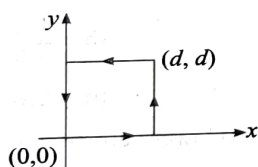
8. The adjoining diagram shows the velocity versus time plot for a particle. The work done by the force on the particle is positive from



- (a) A to B (b) B to C
(c) C to D (d) D to E
9. The relationship between the force F and position x of a body is as shown in figure. The work done in displacing the body from $x = 1$ m to $x = 5$ m will be



- (a) 30 J (b) 15 J (c) 25 J (d) 20 J
10. The work done by the force $\vec{F} = A(y^2\hat{i} + 2x^2\hat{j})$, where A is a constant and x and y are in meters around the path shown is:



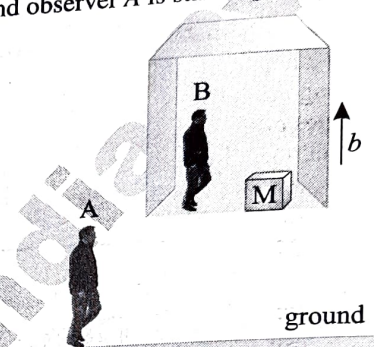
- (a) zero (b) $A d$
(c) $A d^2$ (d) $A d^3$
11. A force $\vec{F} = -K(y\hat{i} + x\hat{j})$ (where K is a positive constant) acts on a particle moving in the xy -plane. Starting from the origin, the particle is taken along the positive x -axis to the

point $(a, 0)$ and then parallel to the y -axis to the point (a, a) . The total work done by the force $\vec{F}$ on the particles is
(a) $-2Ka^2$ (b) $2Ka^2$ (c) $-Ka^2$ (d) Ka^2

Comprehension Type

For Problems 12–14

A block of mass M is kept in elevator (lift) which starts moving upward with constant acceleration ' b ' as shown in figure. Initially elevator at rest. The block is observed by two observers A and B for a time interval $t = 0$ to $t = T$. Observer B is at rest with respect to elevator and observer A is standing on the ground.



12. The observer A finds that the work done by gravity on the block is
(a) $\frac{1}{2}Mg^2T^2$ (b) $-\frac{1}{2}Mg^2T^2$
(c) $\frac{1}{2}MgbT^2$ (d) $-\frac{1}{2}MgbT^2$
13. The observer A finds that work done by normal reaction acting on the block is
(a) $\frac{1}{2}(Mg+b)^2T^2$ (b) $-\frac{1}{2}(Mg+b)^2T^2$
(c) $\frac{1}{2}M(g+b)bT^2$ (d) $-\frac{1}{2}M(g+b)bT^2$
14. According to observer B
(a) The work done by gravity on the block is zero
(b) The work done by normal reaction on the block is zero
(c) The work done by pseudo force on the block is zero
(d) All the above are correct

Answers Key

Single Correct Answer Type

1. (b) 2. (b) 3. (d) 4. (b) 5. (c)
6. (c) 7. (d) 8. (a) 9. (b) 10. (d)
11. (c)

Comprehension Type

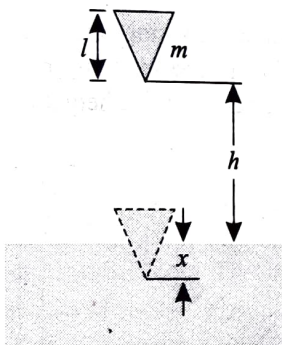
12. (d) 13. (c) 14. (d)

DPP 8.2

Work-Energy Theorem

Subjective Type

- 1 kg particle at a height of 4 m has a speed of 2 m/s down a incline making an angle 53° with horizontal as shown in figure. It slides on a horizontal section of length 3 m at ground level and then up an incline making an angle 37° with horizontal. All surfaces have $\mu_k = 0.5$. How far from point O (bottom of right inclined plane), along the incline making an angle 37° with horizontal, does the particle first come to rest?
- A cone of mass ' m ' falls from a height ' h ' and penetrates into sand. The resistance force R of the sand is given by $R = kx^2$. If the cone penetrates up to a distance $x = d$ where $d < \lambda$, then find the value of ' k '.



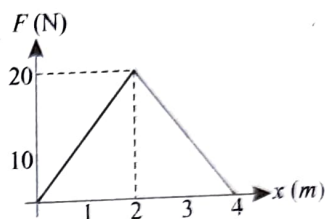
Single Correct Answer Type

- A particle of mass m is moving with speed u . It is stopped by a force F in distance x . If the stopping force is $4F$ then:
 - (a) work done by stopping force in second case will be same as that in first case.
 - (b) work done by stopping force in second case will be 2 times of that in first case.
 - (c) work done by stopping force in second case will be $1/2$ of that in first case.
 - (d) work done by stopping force in second case will be $1/4$ of that in first case.
- Two objects are initially at rest on a frictionless surface. Object 1 has a greater mass than object 2. The same constant force starts to act on each object. The force is removed from each object after it accelerates over a distance d . After the force is removed from both objects, which statement is correct (p : momentum; K : kinetic energy)?

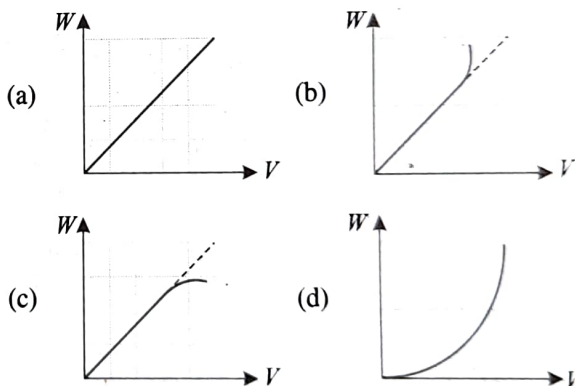
- (a) $p_1 < p_2$
- (c) $K_1 > K_2$

- (b) $p_1 > p_2$
- (d) $K_1 < K_2$

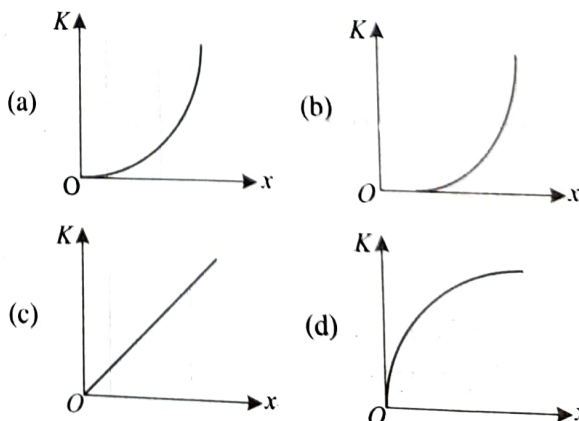
- The graph between the resistive force F acting on a body and the distance covered by the body is shown in the figure. The mass of the body is 25 kg and initial velocity is 2 m/s. When the distance covered by the body is 4 m, its kinetic energy would be
 - (a) 50 J
 - (b) 40 J
 - (c) 20 J
 - (d) 10 J



- A particle, initially at rest on a frictionless horizontal surface, is acted upon by a horizontal force which is constant in size and direction. A graph is plotted between the work done (W) on the particle, against the speed of the particle, (v). If there are no other horizontal forces acting on the particle the graph would look like

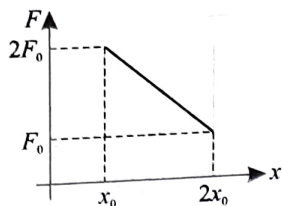


- A body moves from rest with a constant acceleration. Which one of the following graphs represents the variation of its kinetic energy K with the distance travelled x ?



8.4 Mechanics I

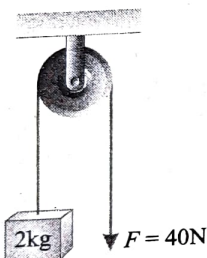
8. A particle of mass m moving along a straight line experiences force F which varies with the distance travelled as shown in the figure. If the velocity of the particle at x_0 is $\sqrt{\frac{2F_0x_0}{m}}$, then velocity at $4x_0$ is:



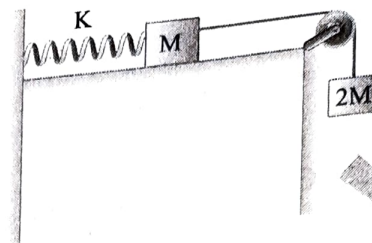
- (a) $2\sqrt{\frac{2F_0x_0}{m}}$ (b) $2\sqrt{\frac{F_0x_0}{m}}$
(c) $\sqrt{\frac{F_0x_0}{m}}$ (d) none of these

Multiple Correct Answers Type

9. A block of mass 2 kg is hanging over a smooth and light pulley through a light string. The other end of the string is pulled by a constant force $F = 40$ N. The kinetic energy of the particle increase 40 J in a given interval of time. Then: ($g = 10 \text{ m/s}^2$)



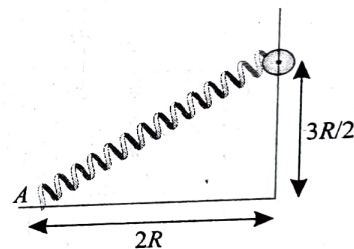
- (a) tension in the string is 40 N
(b) displacement of the block in the given interval of time is 2 m
(c) work done by gravity is -20 J
(d) work done by tension is 80 J
10. Two blocks, of masses M and $2M$, are connected to a light spring of spring constant K that has one end fixed, as shown in figure. The horizontal surface and the pulley are frictionless. The blocks are released from rest when the spring is non deformed. The string is light.



- (a) Maximum extension in the spring is $\frac{4Mg}{K}$.
(b) Maximum kinetic energy of the system is $\frac{2M^2g^2}{K}$
(c) Maximum energy stored in the spring is four times that of maximum kinetic energy of the system.
(d) When kinetic energy of the system is maximum, energy stored in the spring is $\frac{4M^2g^2}{K}$

Comprehension Type

A ring of mass m can slide over a smooth vertical rod. The ring is connected to a spring of force constant $K = \frac{4mg}{R}$ where $2R$ is the natural length of the spring. The other end of the spring is fixed to the ground at a horizontal distance $2R$ from the base of the rod. The mass is released at a height of $1.5R$ from ground.



11. The work done by the spring is
(a) $\frac{mgR}{2}$ (b) $\frac{3mgR}{2}$ (c) $\frac{3mgR}{5}$ (d) mgR
12. The velocity of the ring as it reaches the ground.
(a) $2\sqrt{gR}$ (b) $\sqrt{gR}$ (c) $\frac{\sqrt{gR}}{2}$ (d) $\frac{3\sqrt{gR}}{2}$

Answers Key

Subjective Type

1. 1.2 m 2. $\frac{3mg}{d^3}(h+d)$

Single Correct Answer Type

3. (a) 4. (b) 5. (d) 6. (d) 7. (c)
8. (d)

Multiple Correct Answers Type

9. (a, b, d) 10. (a, b, c)

Comprehension Type

11. (a) 12. (a)

DPP 8.3

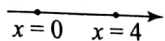
Potential Energy

Subjective Type

1. A particle of mass $m = 1$ kg lying on x -axis experiences a force given by law

$$F = x(3x - 2) \text{ Newton,}$$

where x is the x -coordinate of the particle in meters.



- Locate the points on x -axis where the particle is in equilibrium.
- Draw the graph of variation of force F (y -axis) with x -coordinate of the particle (x -axis). Hence or otherwise indicate at which positions the particle is in stable or unstable equilibrium.
- What is the minimum speed to be imparted to the particle placed at $x = 4$ meters such that it reaches the origin.

Single Correct Answer Type

2. The potential energy of a body is given by, $U = A - Bx^2$ (Where x is the displacement). The magnitude of force acting on the particle is

- Constant
- Proportional to x
- Proportional to x^2
- Inversely proportional to x

3. The potential energy between two atoms in a molecule

is given by $U(x) = \frac{a}{x^{12}} - \frac{b}{x^6}$, where a and b are positive

constants and x is the distance between the atoms. The atom is in stable equilibrium when

- $x = \sqrt[6]{\frac{11a}{5b}}$
- $x = \sqrt[6]{\frac{a}{2b}}$
- $x = 0$
- $x = \sqrt[6]{\frac{2a}{b}}$

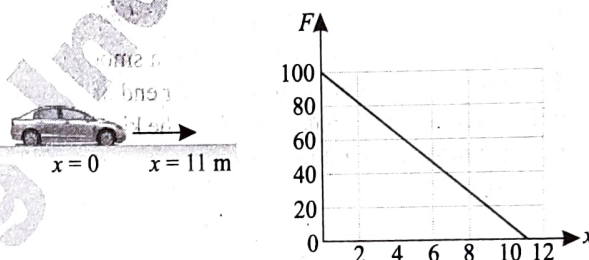
4. Two identical cylindrical vessels with their bases at same level each contains a liquid of density ρ . The height of the liquid in one vessel is h_1 and that in the other vessel is h_2 . The area of either base is A . The work done by gravity in equalizing the levels when the two vessels are connected, is

- $(h_1 - h_2)g\rho$
- $(h_1 - h_2)gA\rho$
- $\frac{1}{2}(h_1 - h_2)^2gA\rho$
- $\frac{1}{4}(h_1 - h_2)^2gA\rho$

5. A particle of mass m is moving in a horizontal circle of radius r under a centripetal force equal to $-K/r^2$, where K is a constant. The total energy of the particle is

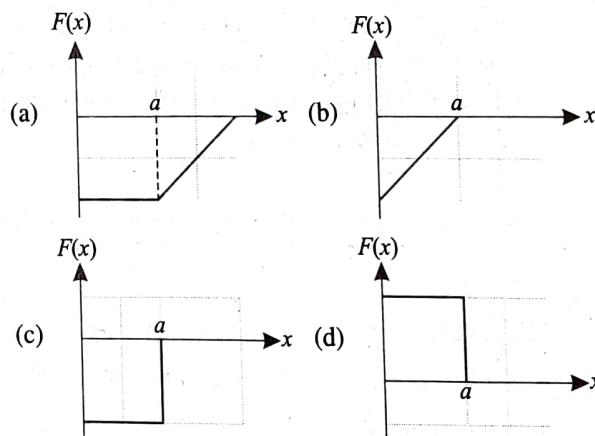
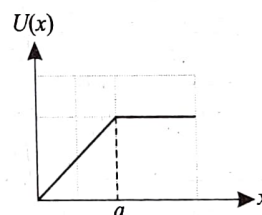
- $\frac{K}{2r}$
- $-\frac{K}{2r}$
- $-\frac{K}{r}$
- $\frac{K}{r}$

6. A toy car of mass 5 kg moves up a ramp under the influence of force F plotted against displacement x . The maximum height attained is given by

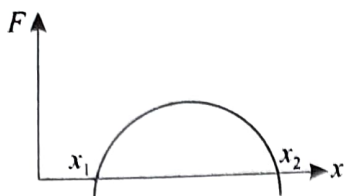


- $v_{\max} = 20$ m
- $v_{\max} = 15$ m
- $v_{\max} = 11$ m
- $v_{\max} = 5$ m

7. The potential energy of a system is represented in the first figure. The force acting on the system will be represented by



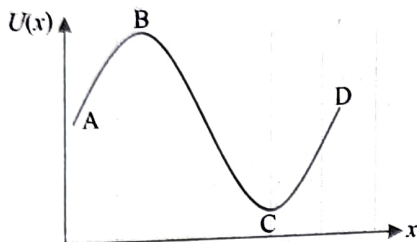
8. The force acting on a body moving along x -axis varies with the position of the particle as shown in the fig.



The body is in stable equilibrium at

- (a) $x = x_1$ (b) $x = x_2$
(c) both x_1 and x_2 (d) neither x_1 nor x_2

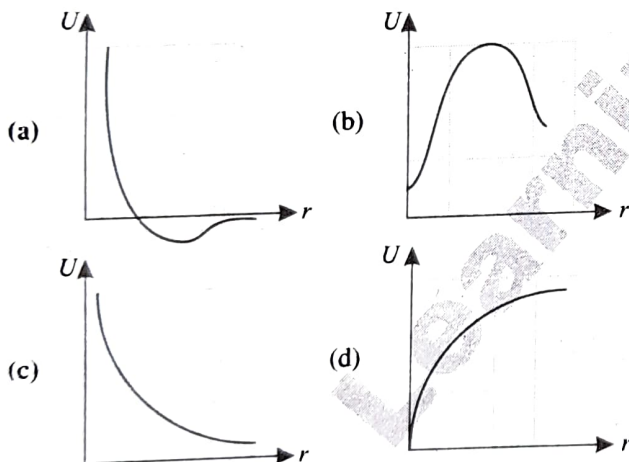
9. The potential energy of a particle varies with distance x as shown in the graph.



The force acting on the particle is zero at

- (a) C (b) B
(c) B and C (d) A and D

10. The diagrams represent the potential energy U of a function of the inter-atomic distance r . Which diagram corresponds to stable molecules found in nature.



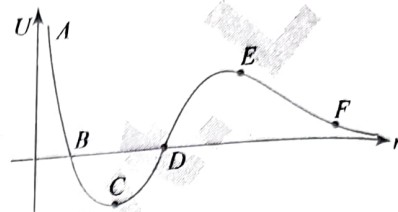
11. One end of an unstretched vertical spring is attached to the ceiling and an object attached to the other end is slowly lowered to its equilibrium position. If S be gain in spring energy and G be loss in gravitational potential energy in the process, then

- (a) $S = G$
(c) $G = 2S$

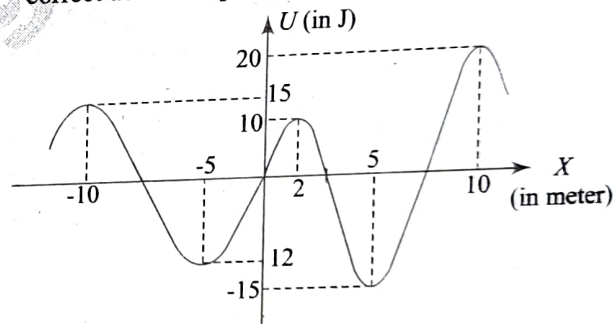
- (b) $S = 2G$
(d) None of these

Multiple Correct Answers Type

12. The given plot shows the variation of U , the potential energy of interaction between two particles with the distance separating them, r . Then which of the following statements are correct.



- (a) B and D are equilibrium points
(b) C is a point of stable equilibrium
(c) The force of interaction between the two particles is attractive between points C and D and repulsive between points D and E on the curve.
(d) The force of interaction between the particles is repulsive between points E and F on the curve.
13. In the figure the variation of potential energy of a particle of mass $m = 2$ kg is represented w.r.t. its x -coordinate. The particle moves under the effect of this conservative force along the x -axis. Which of the following statements are correct about the particle:



- (a) If it is released at the origin it will move in negative x -axis.
(b) If it is released at $x = 2 + \Delta$ where $\Delta \rightarrow 0$ then its maximum speed will be 5 m/s and it will perform oscillatory motion
(c) If initially $x = -10$ m and $\vec{u} = \sqrt{6}\hat{i}$ m/s then it will cross $x = 10$ m
(d) $x = -5$ m and $x = +5$ m are unstable equilibrium positions of the particle

Answers Key

Subjective Type

1. (a) At $x = 0$ and $x = \frac{2}{3}m$

- (b) stable equilibrium at $x = 0$ metre and unstable equilibrium at $x = \frac{2}{3}$ metre

- (c) $\sqrt{\frac{2600}{27}}$ m/s

Single Correct Answer Type

2. (b) 3. (d) 4. (d) 5. (b) 6. (c)
7. (c) 8. (b) 9. (c) 10. (a) 11. (c)

Multiple Correct Answers Type

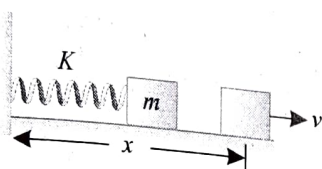
12. (b, d) 13. (a, b, c)

DPP 8.4

Conservation of Mechanical Energy

Subjective Type

1. A block of mass ' m ' is pushed against a spring of spring constant ' k ' fixed at one end to a wall. The block can slide on a frictionless table as shown in the figure. The natural length of the spring is L_0 and it is compressed to one-fourth of natural length and the block is released. Find its velocity as a function of its distance (x) from the wall and maximum velocity of the block. The block is not attached to the spring.



2. Consider a one-dimensional motion of a particle with total energy E . There are four regions A, B, C and D in which the relation between potential energy U , kinetic energy (K) and total energy E is as given below
 Region A: $U > E$ Region B: $U < E$
 Region C: $K < E$ Region D: $U > E$
 State with reason in each case whether a particle can be found in the given region or not.
3. A curved surface is shown in figure. The portion BCD is free of friction. There are three spherical balls of identical radii and masses. Balls are released from rest one by one from A which is at a slightly greater height than C.



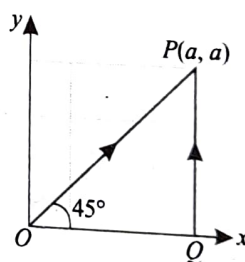
With the surface AB , ball 1 has large enough friction to cause rolling down without slipping; ball 2 has a small friction and ball 3 has a negligible friction.

- For which balls is total mechanical energy conserved?
- Which ball(s) can reach D?
- For balls which do not reach D, which of the balls can reach back A?

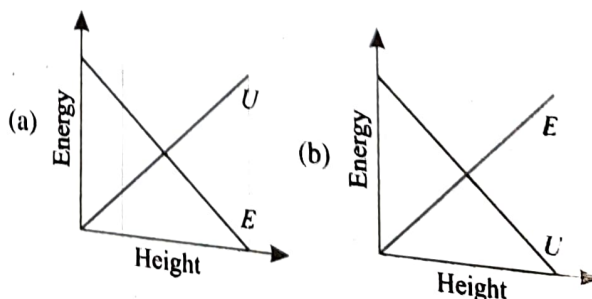
Single Correct Answer Type

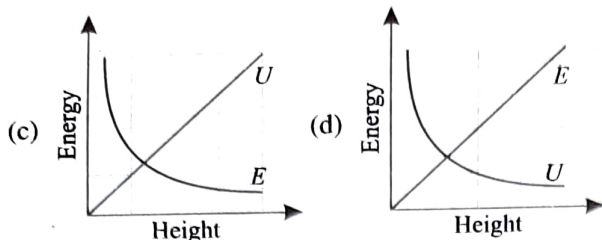
4. Select the correct alternative.
 (a) Work done by kinetic friction on a body always results in a loss of its kinetic energy.

- Work done on a body, in the motion of that body over a close loop is zero for every force in nature.
 - Total mechanical energy of a system is always conserved no matter what type of internal and external forces on the body are present.
 - When total work done by a conservative force on the system is positive then the potential energy associated with this force decreases.
5. A particle is moved from $(0, 0)$ to (a, a) under a force $F = (3\hat{i} + 4\hat{j})$ from two paths. Path 1 is OP and Path 2 is OQP . Let W_1 and W_2 be the work done by this force in these two paths. Then



- $W_1 = W_2$
 - $W_1 = 2W_2$
 - $W_2 = 2W_1$
 - $W_2 = 4W_1$
6. A spherical ball of mass 20 kg is stationary at the top of a hill of height 100 m. It slides down a smooth surface to the ground, then climbs up another hill of height 30 m and finally slides down to a horizontal base at a height of 20 m above the ground. The velocity attained by the ball is
- 10 m/s
 - $10\sqrt{30}$ m/s
 - 40 m/s
 - 20 m/s
7. Which of the following graphs is correct between kinetic energy (E), potential energy (U) and height (h) from the ground of the particle?





8. A ball is suspended from the top of a cart by a string of length 1.0 m. The cart and the ball are initially moving to the right at constant speed V , as shown in figure I. The cart comes to rest after colliding and sticking to a fixed bumper, as in figure II. The suspended ball swings through a maximum angle 60° . The initial speed V is (take $g = 10 \text{ m/s}^2$)

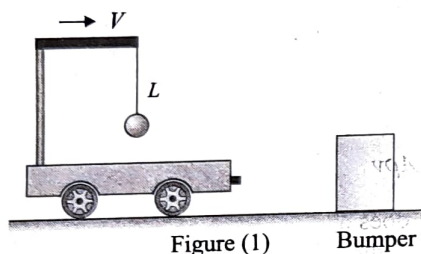


Figure (1)

Bumper

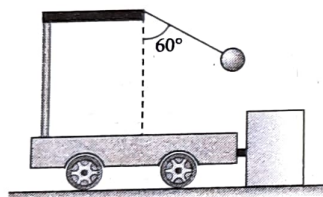
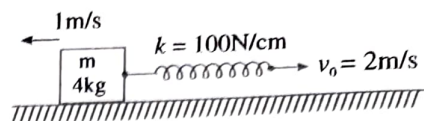


Figure (2)

Bumper

- (a) $\sqrt{10} \text{ m/s}$ (b) $2\sqrt{5} \text{ m/s}$
 (c) $5\sqrt{2} \text{ m/s}$ (d) 4 m/s
9. The spring block system lies on a smooth horizontal surface. The free end of the spring is being pulled towards right with constant speed $v_0 = 2 \text{ m/s}$. At $t = 0$ sec, the spring of constant $k = 100 \text{ N/cm}$ is unstretched and the block has a speed 1 m/s to left. The maximum extension of the spring is



- (a) 2 cm (b) 4 cm (c) 6 cm (d) 8 cm
10. The potential energy of a particle of mass m free to move along x -axis is given by $U = \frac{1}{2} kx^2$ for $x < 0$ and $U = 0$ for $x \geq 0$ (x denotes the x -coordinate of the particle and k is a positive constant). If the total mechanical energy of the particle is E , then its speed at $x = -\sqrt{\frac{2E}{k}}$ is
- (a) zero (b) $\sqrt{\frac{2E}{m}}$
 (c) $\sqrt{\frac{E}{m}}$ (d) $\sqrt{\frac{E}{2m}}$
11. In a shotput event an athlete throws the shotput of mass 10 kg with an initial speed of 1 m/s at 45° from a height 1.5 m above ground. Assuming air resistance to be negligible and acceleration due to gravity to be 10 m/s^2 , the kinetic energy of the shotput when it just reaches the ground will be
- (a) 2.5 J (b) 5.0 J (c) 52.5 J (d) 155.0 J

Multiple Correct Answers Type

12. One of the forces acting on a particle is conservative then which of the following statement(s) are true about this conservative force
- (a) Its work is zero when the particle moves exactly once around any closed path.
 (b) Its work equals the change in the kinetic energy of the particle
 (c) Then that particular force must be constant.
 (d) Its work depends on the end points of the motion, not on the path between.

Answers Key

Subjective Type

1. $v_{\max} = \frac{3L_0}{4} \sqrt{\frac{k}{m}}$
 2. Region B, C and D
 3. (a) Balls 1 and 3 (b) ball 3 (c) balls 1 and 2

Single Correct Answer Type

4. (d) 5. (a) 6. (c) 7. (a) 8. (a)
 9. (c) 10. (a) 11. (d)

Multiple Correct Answers Type

12. (a, d)

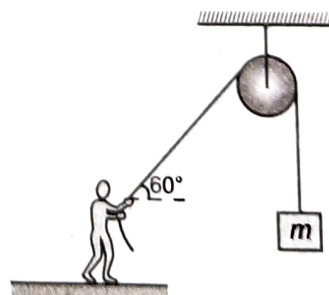
DPP 8.5

Mechanical Power

Single Correct Answer Type

- A body of mass m accelerates uniformly from rest to v_1 in time t_1 . As a function of time t , the instantaneous power delivered to the body is
 (a) $\frac{mv_1 t}{t_1}$ (b) $\frac{mv_1^2 t}{t_1}$ (c) $\frac{mv_1 t^2}{t_1}$ (d) $\frac{mv_1^2 t}{t_1^2}$
- A man is riding on a cycle with velocity 7.2 km/hr up a hill having a slope 1 in 20. The total mass of the man and cycle is 100 kg. The power of the man is
 (a) 200 W (b) 175 W (c) 125 W (d) 98 W
- Power of a water pump is 2 kW. If $g = 10 \text{ m/sec}^2$, the amount of water it can raise in one minute to a height of 10 m is
 (a) 2000 litre (b) 1000 litre (c) 100 litre (d) 1200 litre
- An engine develops 10 kW of power. How much time will it take to lift a mass of 200 kg to a height of 40 m ($g = 10 \text{ m/sec}^2$)?
 (a) 4 sec (b) 5 sec (c) 8 sec (d) 10 sec
- A car of mass ' m ' is driven with acceleration ' a ' along a straight level road against a constant external resistive force ' R '. When the velocity of the car is ' V ', the rate at which the engine of the car is doing work will be
 (a) RV (b) maV (c) $(R + ma)V$ (d) $(ma - R)V$
- A force applied by an engine of a train of mass $2.05 \times 10^6 \text{ kg}$ changes its velocity from 5 m/s to 25 m/s in 5 minutes. The power of the engine is
 (a) 1.025 MW (b) 2.05 MW (c) 5 MW (d) 6 MW
- An engine pumps up 100 kg of water through a height of 10 m in 5 s. Given that the efficiency of the engine is 60%. If $g = 10 \text{ ms}^{-2}$, the power of the engine is
 (a) 3.3 KW (b) 0.33 KW (c) 0.033 KW (d) 33 KW
- From an automatic gun a man fires 360 bullet per minute with a speed of 360 km/hour. If each weighs 20 g, the power of the gun is

- (a) 600 W (b) 300 W (c) 150 W (d) 75 W
- An engine pump is used to pump a liquid of density ρ continuously through a pipe of cross-sectional area A . If the speed of flow of the liquid in the pipe is v , then the rate at which kinetic energy is being imparted to the liquid is
 (a) $\frac{1}{2} A \rho v^3$ (b) $\frac{1}{2} A \rho v^2$ (c) $\frac{1}{2} A \rho v$ (d) $A \rho v$
- A man does a given amount of work in 10 sec. Another man does the same amount of work in 20 sec. The ratio of the output power of first man to the second man is
 (a) 1 (b) 1/2 (c) 2/1 (d) None of these
- An engine can pull 4 coaches at a maximum speed of 20 m/s. Mass of the engine is twice the mass of every coach. Assuming resistive forces to be proportional to the weight, approximate maximum speeds of the engine when it pulls 12 and 6 coaches are:
 (a) 8.5 m/s and 15 m/s respectively (b) 6.5 m/s and 8 m/s respectively (c) 8.5 m/s and 13 m/s respectively (d) 10.5 m/s and 15 m/s respectively
- A man is supplying a constant power of 500 J/s to a massless string by pulling it at a constant speed of 10 m/s as shown. It is known that kinetic energy of the block is increasing at a rate of 100 J/s. Then the mass of the block is:



- (a) 5 kg (b) 3 kg (c) 10 kg (d) 4 kg

Answers Key

Single Correct Answer Type

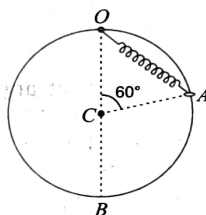
1. (d) 2. (d) 3. (d) 4. (c) 5. (c) 6. (b) 7. (a) 8. (a) 9. (a) 10. (c)
 11. (a) 12. (d)

DPP 8.6

Circular Motion in Vertical Plane

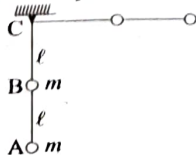
Subjective Type

1. A particle of mass $m = 5$ kg is free to slide on a smooth ring of radius $r = 20$ cm fixed in a vertical plane. The particle is attached to one end of a spring whose other end is fixed to the top point O of the ring. Initially the particle is at rest at a point A of the ring such that $\angle OCA = 60^\circ$, C being the centre of the ring. The natural length of the spring is also equal to $r = 20$ cm. After the particle is released and slides down the ring the contact force between the particle and the ring becomes zero when it reaches the lowest position B (diametrically opposite to O). Determine the force constant of the spring.



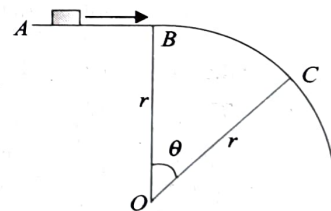
Single Correct Answer Type

2. A block of mass m at the end of a string is whirled round in a vertical circle of radius R . The critical speed of the block at the top of its swing below which the string would slacken before the block reaches the top is
(a) Rg (b) $(Rg)^2$ (c) R/g (d) $\sqrt{Rg}$
3. A sphere is suspended by a thread of length l . What minimum horizontal velocity has to be imparted the ball for it to reach the height of the suspension?
(a) gl (b) $2gl$ (c) $\sqrt{gl}$ (d) $\sqrt{2gl}$
4. A stone of mass 1 kg tied to a light inextensible string of length $L = \frac{10}{3}$ m is whirling in a circular path of radius L in a vertical plane. If the ratio of the maximum tension in the string to the minimum tension in the string is 4 and if g is taken to be 10 m/sec², the speed of the stone at the highest point of the circle is
(a) 20 m/sec (b) $10\sqrt{3}$ m/sec
(c) $5\sqrt{2}$ m/sec (d) 10 m/sec
5. A weightless rod of length 2λ carries two equal masses ' m ', one tied at lower end A and the other at the middle of the rod at B . The rod can rotate in vertical plane about a fixed horizontal axis passing through C . The rod is released from

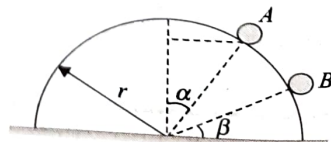


rest in horizontal position. The speed of the mass B at the instant rod become vertical is:

- (a) $\sqrt{\frac{3gl}{5}}$ (b) $\sqrt{\frac{4gl}{5}}$ (c) $\sqrt{\frac{6gl}{5}}$ (d) $\sqrt{\frac{7gl}{5}}$
6. A particle is rotated in a vertical circle by connecting it to a light rod of length l and keeping the other end of the rod fixed. The minimum speed of the particle when the light rod is horizontal for which the particle will complete the circle is
(a) $\sqrt{gl}$ (b) $\sqrt{2gl}$ (c) $\sqrt{3gl}$ (d) none
7. A particle originally at rest at the highest point of a smooth vertical circle is slightly displaced. It will leave the circle at a vertical distance h below the highest point, such that h is equal to
(a) R (b) $R/4$ (c) $R/2$ (d) $R/3$
8. A small block slides with velocity $v_0 = 0.5\sqrt{gr}$ on the horizontal frictionless surface as shown in the fig. The block leaves the surface at point C . The angle θ in the figure is:

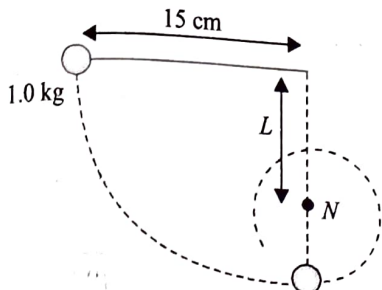


- (a) $\cos^{-1} \frac{4}{9}$ (b) $\cos^{-1} \frac{3}{4}$
(c) $\cos^{-1} \frac{1}{4}$ (d) $\cos^{-1} \frac{4}{5}$
9. A particle moves from rest at A on the surface of a smooth circular cylinder of radius r as shown. At B it leaves the cylinder. The equation relating α and β is



- (a) $3 \sin \alpha = 2 \cos \beta$ (b) $2 \sin \alpha = 3 \cos \beta$
(c) $3 \sin \beta = 2 \cos \alpha$ (d) $2 \sin \beta = 3 \cos \alpha$

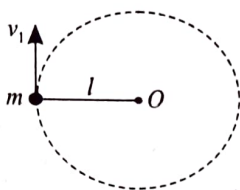
10. A ball weighing 1.0 kg is tied to a string 15 cm long. Initially the ball is held in position such that the string is horizontal. The ball is now released. A nail N is situated vertically below the support at a distance L . The minimum value of L such that the string will be wound round the nail is



- (a) 15 cm
(b) 4 cm
(c) 9 cm
(d) None of these

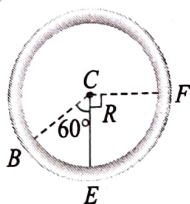
Multiple Correct Answers Type

11. A particle of mass m is attached to a light string of length l , the other end of which is fixed. Initially the string is kept horizontal and the particle is given an upward velocity v . The particle is just able to complete a circle.



- (a) The string becomes slack when the particle reaches its highest point.
(b) The velocity of the particle becomes zero at the highest point.
(c) The kinetic energy of the ball in initial position was $\frac{3}{2} mgl$.
(d) The velocity of the particle at the highest point is $\sqrt{gl}$.

12. As shown in figure BEF is a fixed vertical circular tube. A block of mass m starts moving in the tube at point B with velocity V towards E . It is just able to complete the vertical circle, then

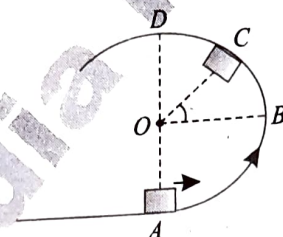


- (a) velocity at B must be $\sqrt{3Rg}$.

- (b) velocity at F must be $\sqrt{2Rg}$.
(c) Normal reaction at point F is $2mg$.
(d) The normal reaction at point E is $6mg$.

Comprehension Type

A small block of mass m is pushed on a smooth track from position A with a velocity $\frac{2}{\sqrt{5}}$ times the minimum velocity required to reach point D . The block will leave the contact with track at the point where normal force between them becomes zero.



13. At what angle θ with horizontal does the block get separated from the track?

- (a) $\sin^{-1}(1/3)$
(b) $\sin^{-1}(3/4)$
(c) $\sin^{-1}(2/3)$
(d) never leaves contact with the track

14. When the block reaches the point B , what is the direction (in terms of angle with horizontal) of acceleration of the block?

- (a) $\tan^{-1}(1/2)$
(b) $\tan^{-1}(2)$
(c) $\sin^{-1}(2/3)$
(d) the block never reaches point B .

15. Find where the maximum contact force occurs between the block and the track.

- (a) at B
(b) at C
(c) somewhere between A and B
(d) at A

Answers Key

Subjective Type

1. 500 N/m

Single Correct Answer Type

2. (d) 3. (d) 4. (d) 5. (c) 6. (b)
7. (d) 8. (b) 9. (c) 10. (c)

Multiple Correct Answers Type

11. (a, c, d) 12. (a, b, c)

Comprehension Type

13. (c) 14. (a) 15. (d)